CLIMATE CHANGE
ADAPTATION REPORT

N Smith BA, FCMA
Finance and Regulation Director
Portsmouth Water Ltd
PO Box 8
West Street
Havant
Hants
PO9 1LG

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CLIMATE CHANGE ADAPTATION REPORT SUMMARY

Background

Portsmouth Water has prepared this report to comply with the direction issued by the Secretary of State to Portsmouth Water under Section 62(1) of the Climate Change Act 2008. This report has been prepared in accordance with the statutory guidance to reporting authorities published by Defra.

The Executive Summary is structured as required in Annex B of the statutory guidance.

(1) **Information on Organisation**

Portsmouth Water Activities

Portsmouth Water is one of 22 water companies in England and Wales. It supplies an average of 180 million litres of water every day to a population of 660,000, together with 18,000 businesses, in an area of 868 square kilometres that straddles the border between Hampshire and West Sussex. The area of supply ranges from Fareham and Bishop's Waltham in the west to Ford and Middleton-on-Sea in the east, and inland as far as the highest points of the South Downs. The majority of the population lives on the coastal plain in the urban areas of Fareham, Gosport, Havant, Waterlooville, Portsmouth, Chichester and Bognor Regis.

Portsmouth Water's mission statement is "We aim to supply drinking water of the highest quality providing high levels of customer service and excellent value for money".

To achieve this mission Portsmouth Water recognise the importance of long term strategic planning. Climate change is a long term risk to the business that has the potential to impact all activities in the business now and in the future. The Company is seeking to integrate the impacts of climate change in their strategic planning functions so operational activities will not be adversely impacted by climate change in the future.

The Company's day to day core operational activities involve collecting water from the environment, treating the water and transporting it to customers. Climate change has the potential to impact all of these activities. The key strategic areas are:

- *Sufficiency of Water Available in Existing Sources*
  Climate change will lead to differing rainfall in the future years in quantity and frequency. Consequently there is a risk that in the future there will not be sufficient water available in existing sources to meet projected demand.

- *Increasing and Changing Demand Patterns for Water*
  The changing climate is likely to result in changes to the amount of water people wish to use and the times of the year they wish to use it. This may result in potential shortages of water which could be exacerbated by changes to the availability of water in the environment.

- *Quality of Water Available for Abstraction*
  Climate change has the potential to cause a deterioration in the quality of the raw water abstracted at some sources. This has the potential to trigger major investment requirements to provide suitable treatment or abandonment of the source.

- *Performance of Assets*
  Climate change may impact the deterioration rate, failure modes and operating efficiency of the Company's assets associated with abstracting, treating and distributing water.

- *Resilience of Assets*
  The Company's assets will be exposed to more extreme weather events in the future. Increased risk of flooding from intense rainfall events has the potential to impact the reliability of the water supply.

- *Sea Level Rise*
  Portsmouth Water's area of supply includes a significant proportion of coast line. The projected sea level rise presents a risk to some of Portsmouth Water's assets that are sited along the coast.

(2) **Business preparedness before Direction to report was issued**

Portsmouth Water's long term strategy and day to day operational activities have always taken account of the risk posed from changes in climate conditions. In some areas of the business climate change predictions have been explicitly used and quantatively incorporated. Other areas of the business have used historical climate data and then included an allowance for the uncertainty resulting from climate change. In some mainly day to day operational activity historic climate data has been used with no allowance for climate change made at present.

The Company also carries out climate change mitigation activities in accordance with its Carbon Management Plan.

Water Resources Management Plan (WRMP)

Climate change predictions have been incorporated into Portsmouth Water's Water Resources Management Plan which determines how the Company intends to balance supply and demand over the coming 25 years. The plan used UKCIP02 data to forecast the impacts of climate change on the Company's sources, though only the impact on surface water sources was incorporated, as the results for groundwater sources were contradictory. The methodology for forecasting changing patterns for consumer demand took account of the impact of climate change. The plan for strategically managing supply and demand includes the following measures:-

- Leakage saving initiative 2016-2020
- Farlington washwater recovery 2018
- Compulsory metering 2016-2030
- Havant Thicket Winter Storage Reservoir 2035

The Company is currently working with the industry to develop suitable methodologies to allow the UKCP09 projections to be used in future water resources planning activity.

Resilience and Emergency Planning

The Company undertook a Flood Resilience Assessment in 2009 which led to resilience improvement measures scheduled for AMP 5 (2010-2015) at four works. Two of these were identified as being within Flood Zone 3, vulnerable to flooding from a 1 in 100 year fluvial event or a 1 in 200 year coastal event. Two further sites were known to be susceptible to repeated groundwater flooding.

The assessment for each of these sites was carried out using data from the Environment Agency.

The resilience measures to be undertaken are currently in the detailed design stage, but are likely to be comprised of relatively modest measures of raising cabling and providing flood defences on air bricks and doorways. The measures scheduled incorporate a further allowance to allow for the impacts of climate change on the flood risk.

The Company has an Emergency Plan which includes managing the impacts of flooding, drought and storms. The Plan is audited annually by Defra.

Drinking Water Safety Plan (DWSP)

The Drinking Water Safety Plan is the operational plan for managing water quality risks, including weather-driven and weather-related risks. These include temperature, sunlight and rainfall-driven water quality risks, such as algal growth, bacterial growth, runoff from intense rain, contaminant concentrations in water courses, infiltration of treated water assets and chlorine depletion.

The DWSP does not explicitly include an assessment of possible future climate exposure. The risk assessments for weather related impacts are based on historic climate data and emerging trends extrapolated forward. The historic climate data by definition will include changes to the climate already experienced and consequently implicitly includes an assessment of climate change that has already occurred.

(3) Identifying risks due to the impacts of climate change

Portsmouth Water have expertise in the business to undertake long term strategic planning. To successfully carry out this function a variety of skills have been developed in the business. These skills include an understanding of climate change, the sources of data available and tools and methodologies available for assessing climate change risk. The Company also has staff dedicated to managing climate risk.

A full list of the evidence utilised in undertaking this climate risk assessment is detailed in Section 4 of the main report. The key data sources utilised were:

- UK Climate Projections 2009
- Information on Portsmouth Water's assets, plans, objectives and stakeholders
- A number of external expert appraisals of climate change risks to infrastructure
- Industry research and publications such as the joint work undertaken by Water UK and MWH in 2007

Elements of the analysis for climate change assessment are embedded within the business so it is not possible to provide an estimate of the total resources attributed to climate change risk assessment. However we estimate approximately 300 hours of staff time were utilised to produce this report.

(4) Assessing Risks

Portsmouth Water operates a risk management system which is reviewed at least annually by the Board of Directors. The Company's risk register is reviewed on a monthly basis by the senior management team at the Management Board. Risks identified as a result of climate change will be recorded on the Company's risk register. In addition specific items relating to climate change are included as a Board item as appropriate. Portsmouth Water's activities are ultimately related to public health and consequently the approach to risk is a precautionary one.

The methodology to score risk in this assessment has been based on a 5 x 5 risk matrix, this provides appropriate granularity to the assessment allowing risks to be separated so that they could be prioritised accordingly. The preferred method for scoring likelihood and consequence is a quantative assessment that is objective and repeatable. The risk scores have been reviewed to provide a level of objectivity and consistency. All risks have been scored at individual asset or activity level, the findings have then been aggregated where appropriate to avoid duplication.

The consequence and likelihood bandings developed for scoring the risk are shown in the table below. A single definition of likelihood was used across all business functions which incorporates both incremental changes in a climate variable and incremental changes in the return period of a key event. To accommodate the different functions across the business four different descriptions for consequence banding were used. This provided a mechanism to ensure consistent assessments of consequence were made across the business. Certainty in each assessment was assessed as high, medium or low.

The table below shows the risk scoring methodology we have utilised.

Score	**Likelihood** of critical threshold being exceeded	**Consequence Score** if critical threshold exceeded	**Consequence** for service (Water Resources and Abstraction)	**Consequence** for service (Water Quality)	**Consequence** for asset and environment.	**Consequence** for Company
1	Very low / Negligible (1 in 1000)	Negligible	Negligible	Negligible	Negligible	Negligible
2	Unlikely (1 in 10)	Minor (low)	Moderately affecting source of normal daily output maximum of <=20 Ml/d	Aesthetic impact for 1 consumer	Minor environmental impact. Minor asset loss.	Minor financial costs incurred. Minor disruption.
3	Moderately likely; (1 in 50)	Moderate	Significantly affecting source of normal daily output maximum of <=20 Ml/d. Moderately affecting source of normal daily output maximum of 20-40 Ml/d.	Aesthetic impact for up to 10 consumers Up to 10 discoloration contacts Up to 2 taste and odour contacts	Moderate environmental impact. Moderate asset loss.	Moderate financial costs incurred. Moderate disruption.
4	Highly likely (1 in 10)	Significant (high)	Significantly affecting source of normal daily output maximum of 20-40 Ml/d. Moderately affecting source of normal daily output maximum of >40Ml/d	Potential health related impact for up to 10 customers. Aesthetic impact up to 1000 customers. Over 50 discoloration contacts. 5 or more taste contacts. Actual multiple failures of one or more standards.	Significant environmental impact. Significant asset loss.	Significant financial costs incurred. Significant disruption.
5	Inevitable (Once a year)	Major (very high)	Significantly affecting source of normal daily output maximum of >40 Ml/d	Potential health related impact for more than 10 customers. Aesthetic impact for over 1000 customers. Actual multiple failures of one or more standards.	Extensive environmental impact. Major/critical asset loss.	Major financial costs incurred. Major disruption.

(5) **<u>Uncertainties and Assumptions</u>**

The main source of uncertainty arises from the range of outcomes in the climate projections UKCP09 with the uncertainty increasing with time. The Company's approach of scoring risks on the basis of near, medium and long term timescales enables the uncertainties associated to be revealed with the risks.

This enables risks to be prioritised accordingly, for example a high risk arising in the near term will be of a higher priority than a high risk in the long term. This priority can then be reflected in the action plan.

The Company has relatively high certainty in assessments of near term risks from climate change. For the longer term assessments included in this report, certainty reduces as the criticality of a climate impact is dependent upon other factors, including population change, social change, economic change, other catchment users (abstractors, dischargers, polluters), management policies of regional planners, and future agreed service standards.

Research in to climate change impacts, particularly on water resources, is an ongoing process. Portsmouth Water will make use of outcomes from UKWIR projects to incorporate UKCP09 into hydrological modelling.

It has been difficult to isolate the criticality of individual climate variables on the supply/demand balance as this is not within the water resources management planning process.

(6) Assessing current and future risks due to climate change - summary

The table is included at the end of the Executive Summary.

(7) Barriers to implementing adaptation programme

It has been useful to develop a more comprehensive understanding of the climate change impacts on other infrastructure sectors, i.e., the energy, transport, telecommunications and Information Communication Technology (ICT) sectors, and the interdependencies between these sectors and with our own sector. The success of the Company in adapting fully to climate change will depend in part on the other sectors' actions to adapt their infrastructure.

Supply chain risks are also important as the risk relates to external factors beyond the control of Portsmouth Water. However, the Company believes it can effectively manage this risk.

Portsmouth Water is a regulated business and as such must secure funding for activities with agreement of the economic regulator Ofwat. Currently the industry is working on collaborative research projects with the Environment Agency to develop a methodology for incorporating UKCP09 climate change scenarios into the water resources planning process. It is paramount that a workable, robust methodology is developed that Company's can use in preparing their next plans that will allow Ofwat to fund adaptation activities if required.

(8) Report and Review

The actions stated in this report include, where applicable, validation and review commitments to assess the materiality of the effect of implementation, any barriers and uncertainty, and identify successful applications. This is particularly the case where the action is to implement a new process or systems-change, or undertake a capacity building initiative. Reviews of implementation of actions will occur after one year and after the next planning cycle.

Adaptive actions and review commitments are assigned to a member of Senior Management.

The Company undertakes extensive data capture and monitoring activities, such as in asset performance, asset failure, source-to-tap water quality, catchment hydrology, source yields, and demand for water. Much of this data is collected through real-time telemetry and daily monitoring by personnel. Elements of this data are also reported to our regulators.

Trend analysis and trend forecasting with this data is a routine part of Portsmouth Water's business. The Company will therefore identify where an observed trend has a climate driver, such as in the deterioration of an asset cohort or group, raw water quality patterns, trends in hydrology and groundwater, and shifts in demand for water.

The Company will incorporate the outcomes of the climate change assessment into their strategic planning mechanisms. This will ensure benefits of this process feed in to the Company's asset management planning process in an integrated way. The analysis undertaken for this programme will be utilised in future assessments and be used to support and inform decisions on a wider basis.

The Company will also continue to make use of new data such as flood mapping, hydrological modelling and per capita consumption studies. This information will refine the likelihood assessments.

The Company has Emergency Plans in place to manage residual risk.

Climate risks will be embedded within the existing risk management mechanisms of Water Resources Management Planning, Drinking Water Safety Planning, capital planning, and resilience and Emergency Planning.

Climate risks will be incorporated in to the corporate risk register which is reviewed annually by the Board of Directors and monthly by senior managers.

The Company is not locked in to a single adaptive response.

Most of the commitments made in this report are in the form of capacity building and systems change, such as new decision-making criteria on assets and Plans to include climate change risks, as they will have lasting consequences.

The WRMP is reviewed annually and a new Plan is produced every five years. The measures contained within our existing WRMP include both demand-side and supply-side schemes.

(9) **Recognising opportunities**

The Company has identified the following potential opportunities due to the effects of climate change:

For water resources:

- Increased aquifer recharge during a normal winter, from increased winter rainfall, may lead to more water being available for use during the summer months, and during peak demand, due to the three-month time lag in the aquifer. This opportunity does not exist following a dry winter, however.

- Increased soil fracturing during the summer, driven by hotter temperatures, may lead to accelerated aquifer recharge when rains begin. Certainty in this theory is very low.

- Increased winter rainfall could be stored and then used to meet increased summer demands.

For capital maintenance planning and asset failure:

- Warmer winters, specifically an increase in temperature of the coldest night and day of winter, may lead to a reduction in water mains failure (bursts) associated with cold weather and earth movement.

(10) **Further comment/information**

Portsmouth Water welcomes Government's intention to provide direction in climate change adaptation and engage with the water industry in identifying barriers. However, the Company feels that sector-specific guidance should be utilised in the future. In particular, it has been difficult to isolate the criticality of individual climate drivers on the supply-demand balance. Government's approach in future should be more closely aligned with the water resources management planning guidelines.

Table Legend

Risk Score	= Confidence Score X Likelihood Score	
Risk Banding	High Priority	1 - 5
	Medium Priority	6 -12
	Low Priority	13 - 25
Certainty	H High	
	M Medium	
	L Low	

6. Addressing current and future risks due to climate change - summary (one line is required per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	**Likelihood score** (near, medium, long term)	**Consequence score**	**Risk score** (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Water Resources	Sea level rise	Saline intrusion of groundwater (borehole sources)	3mAOD (screening assessment)	Low	1 1 2	4 4 4	**4** **4** **8**	H H M	Continued use of third party flood and coastal change information. Continued engagement with regional planners.	Not this Century
Water Resources	Sea level rise	Saline intrusion of groundwater (Havant and Bedhampton springs source)	3mAOD (screening assessment)	Negligible	1 1 1	2 2 2	**2** **2** **2**	H H M	Continued use of third party flood and coastal change information. Continued engagement with regional planners.	Not this Century
Water Resources	Sea level rise	Estuarine reaches move upstream. Rising salinity at River Itchen intake.	3mAOD (screening assessment)	Negligible	1 1 1	5 5 5	**5** **5** **5**	H H H	Continued use of third party flood and coastal change information. Continued engagement with regional planners.	Not this Century
Water Resources	Sea level rise	Water resources asset loss	3mAOD (screening assessment)	Negligible	1 1 2	2 2 2	**2** **2** **4**	H H H	Continued use of third party flood and coastal change information. Continued engagement with regional planners.	Not this Century
Water Resources	Sea level rise	Population migration away from areas at risk of coastal change.	6,000 properties (2% of our population) (screening level)	Negligible	1 1 1	2 2 2	**2** **2** **2**	H H H	Continued use of third party flood and coastal change information. Continued engagement with spatial planners.	Not this Century
Water Resources	Reduced summer rainfall	Lower groundwater (and/or increased abstraction) leads to saline intrusion		Negligible	1 1 1	4 4 4	**4** **4** **4**	H H H	Ongoing monitoring.	Not this Century
Water Resources	Reduced summer rainfall	Reduced aquifer recharge during summer months leads to reduced source yield in summer	Headroom in WRMP	Negligible	1 1 1	5 5 5	**5** **5** **5**	H H M	Review critical period periodically in WRMP cycles. Make use of modelling undertaken in AMP5 using UKCP09 data (Company, Environment Agency, UKWIR, and others).	Not this Century
Water Resources	Reduced summer rainfall	Reduced aquifer recharge during summer months leads to reduced source yield in October	Headroom in WRMP	Low	1 1 1	3 3 3	**3** **3** **3**	H M L	Review critical period periodically in WRMP cycles. Make use of modelling undertaken in AMP 5 using UKCP09 data (Company, Environment Agency, UKWIR, and others).	Long term (late Century)

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Water Resources	Reduced summer rainfall	Increased abstraction by other catchment users	Headroom in WRMP	High	1 3 4	3 3 3	**3** **9** **12**	L L L	Continued engagement with the Environment Agency. Share knowledge through WRSE, Water UK and other channels.	Medium term (mid-Century)
Water Resources	Reduced summer rainfall	Increased risk of breach of environmental flow requirements in water courses, reducing reliability of sources	Headroom in WRMP	High	3 3 4	3 3 3	**9** **9** **12**	M L L	Undertake AMP 5 investigations and modelling as planned, to enable more certainty in future WRMPing cycles.	Near term (within 20-30 years)
Water Resources	Reduced summer rainfall	Increased demand for water at peak from permanent population	Headroom in WRMP	Very high	1 3 5	5 5 5	**5** **15** **25**	H M M	Continue to research climate drivers of demand through existing channels (Company data, UKWIR, links to University projects, and others). Incorporate impacts into WRMP and undertake supply or demand management schemes according to regulatory guidelines.	Medium term (mid-Century)
Water Resources	Reduced summer rainfall	Increased occurrence of drought	5% chance of drought in a given year, or return period of 1 in 20.	High	1 3 4	5 5 5	**5** **15** **20**	M L L	Make use of modelling undertaken in AMP 5 using UKCP09 data (Company, Environment Agency, and UKWIR). Produce 2011 Drought Plan. Assess the impacts of climate change on the measures in the Plan.	Medium term (mid-Century)
Water Resources	Increased winter rainfall	Population migration out of floodplain	6,000 properties (2% of our population) (screening level)	Low	1 1 2	2 2 2	**2** **2** **4**	H H H	Continued use of third party flood and coastal change information. Continued engagement with regional planners.	Long term (late Century)
Water Resources	Increased winter rainfall	Increased aquifer recharge during winter (climate change opportunity)	N/A	N/A	N/A N/A N/A	N/A N/A N/A	**N/A** **N/A** **N/A**	N/A N/A N/A	Make use of modelling undertaken in AMP 5 using UKCP09 data (Company, Environment Agency, and UKWIR).	Medium term (mid-Century)
Water Resources	More intense winter rainfall	Increased compaction of soil surface leading to reduce aquifer recharge	Headroom in WRMP	Negligible	1 1 1	1 1 1	**1** **1** **1**	H H M	Continue to work with the Environment Agency and other stakeholders on aquifer modelling.	Not this Century
Water Resources	Increased winter rainfall	Population migration away from areas at risk of surface water flooding.	6,000 properties (2% of our population) (screening level)	Low	1 1 2	2 2 2	**2** **2** **4**	H H H	Continued use of third party flood and coastal change information. Continued engagement with spatial planners.	Long term (late Century)

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Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	**Likelihood score** (near, medium, long term)	**Consequence score**	**Risk score** (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Water Resources	Reduced cloud cover	Increase in agriculture leading to increased abstraction by other catchment users	Headroom in WRMP	High	1	3	**3**	L	Continued engagement with the Environment Agency. Share knowledge through WRSE, Water UK and other channels.	Medium term (mid-Century)
					3	3	**9**	L		
					4	3	**12**	L		
Water Resources	Increased summer temperatures	Increased evapotranspiration impacting aquifer recharge	Headroom in WRMP	Low	1	2	**2**	H	Continue to work with the Environment Agency and other stakeholders on aquifer modelling.	Long term (late Century)
					2	2	**4**	M		
					2	2	**4**	L		
Water Resources	Increased summer temperatures	Increased demand for water from permanent population, particularly at peak demand	Headroom in WRMP	Very high	1	5	**5**	H	Continue to research climate drivers of demand through existing channels (Company data, UKWIR, links to University projects, and others). Incorporate impacts into WRMP and undertake supply or demand management schemes according to regulatory guidelines.	Medium term (mid-Century)
					3	5	**15**	H		
					5	5	**25**	M		
Water Resources	Increased summer temperatures	Increased demand for water from seasonal (tourist) population, particularly at peak demand	Headroom in WRMP	Very high	1	5	**5**	H	Continued engagement with regional planners.	Near term (within 20-30 years)
					3	5	**15**	M		
					5	5	**25**	L		
Water Resources	Increased summer temperatures	Increased soil fracturing in summer leads to accelerated aquifer recharge when rains begin.	Headroom in WRMP	N/A	N/A	N/A	N/A	N/A	Continue to work with the Environment Agency and other stakeholders on aquifer modelling.	Medium term (mid-Century)
					N/A	N/A	N/A	N/A		
					N/A	N/A	N/A	N/A		
Water Resources	Increased summer temperatures	Increased demand from net inward migration of retirement population	Headroom in WRMP	Very high	1	3	**3**	H	Continued engagement with regional planners.	Medium term (mid-Century)
					3	3	**9**	M		
					5	3	**15**	L		

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Abstraction	Sea level rise	Abstraction asset loss or outage		Low	1 1 2	2 2 2	**2** **2** **4**		Ongoing monitoring.	Long term (late Century)
Abstraction	Increased summer temperatures	Reduced abstraction pump (M&E) efficiency		Negligible	1 1 1	2 2 2	**2** **2** **2**		Ongoing monitoring.	Not this Century
Abstraction	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration		Low	1 1 2	2 2 2	**2** **2** **4**	H H M	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Long term (late Century)
Abstraction	Increased summer temperatures	Increased heat wave events; road melt impedes access to works		Low	1 1 2	1 1 1	**1** **1** **2**	H H H	Incorporate risk into Emergency Plan.	Long term (late Century)
Abstraction	Increased winter rainfall	Increased flooding to abstraction assets from groundwater and rivers	1 in 100 year risk (Flood Zone)	High	1 3 4	3 3 3	**3** **9** **12**	H M L	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Medium term (mid-Century)
Abstraction	More intense winter rainfall	Increased pluvial flooding to abstraction assets		Low	1 1 2	2 2 2	**2** **2** **4**	H H M	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Long term (late Century)
Abstraction	Increased storminess	Increased interruptions to electricity supply		Low	1 1 2	1 1 1	**1** **1** **2**	H H H	Ongoing monitoring.	Long term (late Century)
Abstraction	Increased storminess	Increased interruptions to telecommunications and telemetry		Low	1 1 2	3 3 3	**3** **3** **6**	H H H	Ongoing monitoring.	Long term (late Century)

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Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	**Likelihood score** (near, medium, long term)	**Consequence score**	**Risk score** (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Abstraction	Increased storminess	Storm damage to buildings and overhead cabling		Low	1	2	**2**	H	Bear losses and/or share losses. Risk is already incorporated into Emergency Plan.	Long term (late Century)
					1	2	**2**	H		
					2	2	**4**	H		
Abstraction	Reduced summer rainfall	River intake too high due to reduced river flows		Negligible	1	2	**2**	H	Ongoing monitoring.	Long term (late Century)
					1	2	**2**	H		
					1	2	**2**	M		

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Raw water quality	Reduced summer rainfall	Contaminants in the River Itchen become more concentrated due to low flows		High	1	3	**3**	H	Continue existing catchment management programme. Incorporate risk in to DWSP. Ongoing monitoring for water quality.	Medium term (mid-Century)
					2	3	**6**	L		
					4	3	**12**	L		
Raw water quality	Reduced summer rainfall	Low flows cause water column temperature to rise. Increased biological and bacterial growth.		Medium	2	2	**4**	H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Near term (within 20-30 years)
					3	2	**6**	M		
					3	2	**6**	L		
Raw water quality	Increased summer temperatures	Higher temperatures in the water column. Increased biological and bacterial growth.		High	2	2	**4**	H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Near term (within 20-30 years)
					3	2	**6**	M		
					4	2	**8**	M		
Raw water quality	More intense winter rainfall	Increased turbidity events from surface runoff into river source and swallow holes (Havant and Bedhampton Springs)		Low	1	2	**2**	H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Medium term (mid-Century)
					2	2	**4**	H		
					2	2	**4**	M		
Raw water quality	Reduced cloud cover	Increased biological growth in the water column.		Very high	2	2	**4**	H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Near term (within 20-30 years)
					4	2	**8**	M		
					5	2	**10**	L		

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Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	**Likelihood score** (near, medium, long term)	**Consequence score**	Risk score (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Raw water transport	Sea level rise	Asset loss or outage (above ground assets)	3mAOD (screening assessment)	Negligible	1 1 1	4 4 4	**4** **4** **4**	H H H	Ongoing monitoring.	Not this Century
Raw water transport	Sea level rise	Saline intrusion of mains leading to water quality risk		Negligible	1 1 1	4 4 4	**4** **4** **4**	H H H	Incorporate risk into DWSP. Ongoing water quality monitoring.	Not this Century
Raw water transport	Increased summer temperatures	Reduced raw water transport pump (M&E) efficiency		Low	1 1 2	2 2 2	**2** **2** **4**	M L L	Ongoing monitoring.	
Raw water transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration (above ground assets)		Negligible	1 1 1	2 2 2	**2** **2** **2**	H H H	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Not this Century
Raw water transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration (below ground assets)		Low	1 1 1	3 3 3	**3** **3** **3**	H M M	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Not this Century
Raw water transport	Increased summer temperatures	Increased heat wave events; road melt impedes access to pumping stations		Negligible	1 1 2	1 1 1	**1** **1** **2**	H H M	Incorporate risk in to Emergency Plan.	Long term (late Century)
Raw water transport	Increased winter rainfall	Increased flooding from groundwater and rivers	1 in 100 year risk (Flood Zone 3)	Medium	1 2 3	3 3 3	**3** **6** **9**	H M M	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Medium term (mid-Century)
Raw water transport	More intense winter rainfall	Increased pluvial flooding		Low	1 1 2	2 2 2	**2** **2** **4**	H H M	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Long term (late Century)
Raw water transport	Increased storminess	Increased interruptions to electricity supply		Negligible	1 1 1	1 1 1	**1** **1** **1**	H H H	Ongoing monitoring.	Not this Century

6. Addressing current and future risks due to climate change - summary (one line is required per risk)										
Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	**Likelihood score** (near, medium, long term)	**Consequence score**	Risk score (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Raw water transport	Increased storminess	Increased interruptions to telecommunications and telemetry		Negligible	1	2	**2**	H	Ongoing monitoring.	Long term (late Century)
					1	2	**2**	H		
					2	2	**4**	H		
Raw water transport	Increased storminess	Storm damage to buildings and overhead cabling		Negligible	1	1	**1**	H	Ongoing monitoring. Bear losses and/or share losses.	Not this Century
					1	1	**1**	H		
					1	1	**1**	H		

6. Addressing current and future risks due to climate change - summary (one line is required per risk)										
Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	**Likelihood score** (near, medium, long term)	**Consequence score**	Risk score (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Raw storage	Sea level rise	Asset loss or outage from coastal change	3mAOD (screening assessment)	Negligible	1	1	**1**	H		Not this Century
					1	1	**1**	H		
					1	1	**1**	H		
Raw storage	Increased summer temperatures	Accelerated asset deterioration		Negligible	1	1	**1**	H	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Not this Century
					1	1	**1**	H		
					1	1	**1**	H		
Raw storage	Increased winter rainfall	Increased flooding from groundwater and rivers	1 in 100 year risk (Flood Zone 3)	Negligible	1	3	**3**	H	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Not this Century
					1	3	**3**	H		
					1	3	**3**	H		
Raw storage	More intense winter rainfall	Increased pluvial flooding		Negligible	1	2	**2**	H	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Not this Century
					1	2	**2**	H		
					1	2	**2**	H		
Raw storage	Increased storminess	Storm damage to asset		Negligible	1	2	**2**	H	Bear losses and/or share losses.	Not this Century
					1	2	**2**	H		
					1	2	**2**	M		

6. Addressing current and future risks due to climate change - summary (one line is required per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	**Likelihood score** (near, medium, long term)	**Consequence score**	Risk score (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Treatment	Sea level rise	Treatment asset loss or outage	3mAOD (screening assessment)	Negligible	1 1 1	1 1 1	**1** **1** **1**	H H H		Not this Century
Treatment	Increased summer temperatures	Reduced treatment pump (M&E) efficiency		Medium	1 2 3	1 1 1	**1** **2** **3**	H M M	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Medium term (mid-Century)
Treatment	Increased summer temperatures	increased bacterial growth in rapid gravity filters		Negligible	1 1 1	3 3 3	**3** **3** **3**	H H H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Not this Century
Treatment	Increased summer temperatures	Increased occurrence of heat wave (road melt) events impeding treatment works access		Medium	1 2 3	2 2 2	**2** **4** **6**	H M M	Incorporate risk in to Emergency Plan.	Medium term (mid-Century)
Treatment	Increased summer temperatures	Increased occurrence of heat wave events disrupting chemicals supply chains		Medium	1 2 3	2 2 2	**2** **4** **6**	H M M	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Medium term (mid-Century)
Treatment	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated treatment asset deterioration		Negligible	1 1 1	2 2 2	**2** **2** **2**	H H H	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Not this Century
Treatment	Increased winter rainfall	Increased flooding from groundwater and rivers	1 in 100 year risk (Flood Zone 3)	High	1 3 4	3 3 3	**3** **9** **12**	H M L	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Medium term (mid-Century)
Treatment	Increased winter rainfall	Regional flooding leading to chemicals supply chain disruption		High	1 2 3	2 2 2	**2** **4** **6**	H M M	Incorporate risk in to DWSP.	Medium term (mid-Century)
Treatment	More intense winter rainfall	Increased pluvial flooding		Low	1 1 2	2 2 2	**2** **2** **4**	H H M	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Long term (late Century)
Treatment	Increased storminess	Increased interruptions to electricity supply		Low	1 1 2	1 1 1	**1** **1** **2**	H H H	Ongoing monitoring.	Long term (late Century)
Treatment	Increased storminess	Increased interruptions to telecommunications and telemetry		Low	1 1 2	3 3 3	**3** **3** **6**	H H H	Ongoing monitoring.	Long term (late Century)

6. Addressing current and future risks due to climate change - summary (one line is required per risk)										
Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	**Likelihood score** (near, medium, long term)	**Consequence score**	Risk score (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Treatment	Increased storminess	Disturbance of the flocculant blanket		Low	1	1	**1**	H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Long term (late Century)
					1	1	**1**	H		
					2	1	**2**	H		
Treatment	Increased storminess	Storm damage to buildings and overhead cabling		Low	1	2	**2**	H	Share losses and/or bear losses.	Long term (late Century)
					1	2	**2**	H		
					2	2	**4**	H		
Treatment	Reduced cloud cover	Algal growth in rapid gravity filters		Negligible	1	1	**1**	H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Not this Century
					1	1	**1**	H		
					1	1	**1**	H		
Treatment	Reduced cloud cover	Algal growth in clarifiers		Negligible	1	1	**1**	H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Not this Century
					1	1	**1**	H		
					1	1	**1**	H		

6. Addressing current and future risks due to climate change - summary (one line is required per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Likelihood score (near, medium, long term)	Consequence score	Risk score (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Potable storage	Sea level rise	Saline intrusion	3mAOD (screening assessment)	Negligible	1 1 1	3 3 3	**3** **3** **3**	H H H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Not this Century
Potable storage	Sea level rise	Potable storage asset loss or outage		Negligible	1 1 1	3 3 3	**3** **3** **3**	H H H	Ongoing monitoring.	Not this Century
Potable storage	Increased summer temperatures	Reduced potable storage pump (M&E) efficiency		Negligible	1 1 1	1 1 1	**1** **1** **1**	H H H	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Not this Century
Potable storage	Increased summer temperatures	Accelerated potable storage asset deterioration		Negligible	1 1 1	1 1 1	**1** **1** **1**	H H H	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Not this Century
Potable storage	Increased summer temperatures	Accelerated chlorine depletion		Low	1 1 2	2 2 2	**2** **2** **4**	H H H	No further action.	Long term (late Century)
Potable storage	Increased winter rainfall	Increased flooding leading to ingress and bacterial contamination		Negligible	1 1 1	3 3 3	**3** **3** **3**	H H H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Not this Century
Potable storage	Increased winter rainfall	Increased flooding causing asset damage	1 in 100 year risk (Flood Zone 3)	Negligible	1 1 1	3 3 3	**3** **3** **3**	H H H	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Not this Century
Potable storage	More intense winter rainfall	Monitoring equipment failure due to flooding	1 in 100 year risk (Flood Zone 3)	Negligible	1 1 1	3 3 3	**3** **3** **3**	H H H	Review next round of flood mapping data when available. Ongoing monitoring.	Not this Century
Potable storage	More intense winter rainfall	Flooding leading to ingress and bacterial contamination		Negligible	1 1 1	3 3 3	**3** **3** **3**	H H H	Review next round of flood mapping data when available. Ongoing monitoring.	Not this Century
Potable storage	More intense winter rainfall	Flooding causing asset damage		Negligible	1 1 1	3 3 3	**3** **3** **3**	H H H	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Not this Century
Potable storage	More intense winter rainfall	Monitoring equipment failure due to flooding		Negligible	1 1 1	3 3 3	**3** **3** **3**	H H H	Review next round of flood mapping data when available. Ongoing monitoring.	Not this Century

6. Addressing current and future risks due to climate change - summary (one line is required per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	**Likelihood score** (near, medium, long term)	**Consequence score**	Risk score (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Potable transport	Sea level rise	Saline intrusion of water mains (metallic mains)		Low	1 1 2	3 3 3	**3** **3** **6**	H M L	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Long term (late Century)
Potable transport	Sea level rise	Saline intrusion of water mains (non-metallic mains)		Negligible	1 1 1	3 3 3	**3** **3** **3**	H H H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Not this Century
Potable transport	Sea level rise	Population migration away from coastal risk; network sizing inappropriate		Negligible	1 1 1	2 2 2	**2** **2** **2**	H H H	Continued engagement with regional planners. Ongoing monitoring.	Not this Century
Potable transport	Sea level rise	Asset loss (water mains) due to coastal change		Negligible	1 1 1	2 2 2	**2** **2** **2**	H M M	Continued engagement with regional planners. Ongoing monitoring.	Not this Century
Potable transport	Increased summer temperatures	Reduced potable transport pump (M&E) efficiency		Negligible	1 1 1	1 1 1	**1** **1** **1**	H H H	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Not this Century
Potable transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration (above ground assets)		Negligible	1 1 1	1 1 1	**1** **1** **1**	H H H	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Not this Century
Potable transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration (below ground assets - cast iron)		High	1 3 4	4 4 4	**4** **12** **16**	H M M	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Medium term (mid-Century)
Potable transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration below ground assets - ductile iron, fibre reinforced concrete, PVC and steel)		Medium	1 2 3	4 4 4	**4** **8** **12**	H M M	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Near term (within 20-30 years)

6. Addressing current and future risks due to climate change - summary (one line is required per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	**Likelihood score** (near, medium, long term)	**Consequence score**	Risk score (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Potable transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration (below ground assets - MDPPE and HPPE)		Negligible	1 1 1	4 4 4	**4** **4** **4**	H H H	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Not this Century
Potable transport	Increased summer temperatures	Accelerated chlorine depletion		Low	1 1 2	2 2 2	**2** **2** **4**	H H M	No further action.	Long term (late Century)
Potable transport	Increased summer temperatures	Increased seasonal (tourist) population; network sizing is insufficient		Negligible	1 1 1	2 2 2	**2** **2** **2**	H H H	Continued engagement with regional planners. Ongoing monitoring.	Not this Century
Potable transport	Increased summer temperatures	Increased heat wave events; road melt impedes routine mains repair		Low	1 1 2	1 2 2	**1** **2** **4**	H H M	Incorporate risk in to Emergency Plan.	Not this Century
Potable transport	Increased winter temperatures	Reduction in mains failure associated with cold weather (climate change opportunity)		N/A	N/A N/A N/A	N/A N/A N/A	N/A N/A N/A	N/A N/A N/A		
Potable transport	Increased winter rainfall	Increased regional flooding; infiltration of below ground assets		Low	1 1 2	1 2 2	**1** **2** **4**	H H M	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Long term (late Century)
Potable transport	Increased winter rainfall	Increased flooding to potable pumps		Medium	1 2 3	3 3 3	**3** **6** **9**	H M M	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Medium term (mid-Century)
Potable transport	Increased winter rainfall	Population migration away from flood risk; network sizing inappropriate		Negligible	1 1 1	1 1 1	**1** **1** **1**	H H H	Continued engagement with regional planners. Ongoing monitoring.	Not this Century
Potable transport	Increased winter rainfall	Increased regional flooding; impedes routine mains repair		Medium	1 2 3	3 3 3	**3** **6** **9**	H M L	Review next round of flood mapping data when available. Ongoing monitoring.	Medium term (mid-Century)

6. Addressing current and future risks due to climate change - summary (one line is required per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	**Likelihood score** (near, medium, long term)	**Consequence score**	Risk score (near, medium, long term)	Certainty	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action planned
Potable transport	Increased winter rainfall	Population migration away from flood risk; network sizing inappropriate		Negligible	1 1 1	1 1 1	**1** **1** **1**	H H H	Continued engagement with regional planners. Ongoing monitoring.	Not this Century
Potable transport	More intense winter rainfall	Increased regional flooding; infiltration of below ground assets		Negligible	1 1 1	1 1 1	**1** **1** **1**	H H H	Incorporate risk in to DWSP. Ongoing monitoring of water quality.	Not this Century
Potable transport	More intense winter rainfall	Increased flooding to pumps		Low	1 1 2	2 2 2	**2** **2** **4**	H H M	Review next round of flood mapping data when available. Ongoing monitoring. Consider future flood risk when developing new assets.	Long term (late Century)
Potable transport	More intense winter rainfall	Increased regional flooding; impedes routine mains repair		Low	1 1 2	2 2 2	**2** **2** **4**	H M L	Undertake periodic review of flood resilience and make use of new information as it becomes available. Undertake improvements where necessary.	Medium term (mid-Century)
Potable transport	Increased storminess	Increased interruptions to electricity supply		Low	1 1 2	1 1 1	**1** **1** **2**	H H H	Ongoing asset performance monitoring. Incorporate climate change risks into investment decision-making when procuring or developing new assets.	Long term (late Century)
Potable transport	Increased storminess	Increased interruptions to telecommunications and telemetry		Low	1 1 2	3 3 3	**3** **3** **6**	H M M	Ongoing monitoring.	Medium term (mid-Century)

1. INTRODUCTION

Climate change is happening, both globally and in the UK. There has been an observed increase in mean global temperature since pre-industrial times, and this has been accompanied by a reduction in sea ice and glaciers, rising sea levels, and more frequent and more extreme weather events such as floods, droughts and storms.

The Intergovernmental Panel on Climate Change (IPCC) stated in their Fourth Assessment Report (AR4) that "it is very likely that anthropogenic greenhouse gas increases caused most of the observed increase in global average temperatures since the mid-20th century".

Measures are being taken by the UK and other governments to reduce global greenhouse gas emissions. However, even if significant reductions in global greenhouse gas emissions are made in the near future, we are still locked-in to a certain amount of future climate change due to past emissions. In fact, the IPCC reported[1] in 2007 that even if the most ambitious global emissions reduction targets are achieved the world has only a 50% chance of keeping global mean temperature rise to below 2ºC by 2100.

In June 2009, the UK Government published the UK Climate Projections 2009 (UKCP09 or "the Projections") which provide probabilistic projections of future climate and climate change for UK territories up to the end of the twenty-first century, based on high, medium and low global greenhouse gas emissions scenarios. The Projections tell us we can expect warmer mean and peak temperatures, wetter winters, drier summers and an increase in the occurrence and severity of extreme weather events such as heatwaves, droughts and intense rainfall.

Portsmouth Water has a duty as a water undertaker to ensure that it meets its customers expectations in terms of the provision of a public water supply in a sustainable manner. The Company has a long history of supplying water to its customers and throughout that period has been acutely aware of the need for long term planning.

Portsmouth Water recognises the importance of understanding climate risk and uncertainty and to incorporate these into planning functions. For example, changes in temperature and precipitation will impact both the supply of and demand for water and may increase water quality risk. There will be opportunities too. The Company will also have to adapt to increased flood risk, coastal change and the likelihood of more frequent extreme weather events.

The purpose of the process undertaken in this report was to:

- Identify the impacts of a changing climate on Portsmouth Water's ability to carry out its functions and continue to deliver secure, wholesome water supplies
- Assess and prioritise climate risks
- Identify adaptation options
- Identify knowledge gaps and barriers to action
- Develop a robust, evidenced adaptation plan
- Outline adaptation measures being taken.

Portsmouth Water has prepared this report to comply with the direction issued by the Secretary of State to Portsmouth Water under Section 62(1) of the Climate Change Act 2008. This report has been prepared in accordance with the statutory guidance to reporting authorities published by Defra.

[1] AR4

2. DRIVERS FOR ADAPTING TO CLIMATE CHANGE

Portsmouth Water recognises the need to include the impacts of climate in their business planning processes. The following drivers have been identified by the business.

2.1 Observed Trends in UK Climate

2.1.1 Temperature

Central England Temperature (CET) is now 1ºC warmer than in the 1970s, and 2006 was the warmest on record. This warming is more marked than the global trend of a 0.8ºC rise since the late 19th century. Globally, the ten warmest years on record have occurred since 1995 and there has been a reduction in Arctic sea ice, northern snow cover and glaciers. In August 2003, the Met Office recorded the highest daily temperature for England of 38.5ºC.

Temperature changes will impact on the demand for water, the availability of water in the environment and the infrastructure used to collect, treat and distribute the water to our customers.

2.1.2 Precipitation

Annual mean precipitation in England has not changed significantly since records began in 1766. However, evidence suggests that there has been a gradual shift towards more rainfall occurring in winter and less occurring in summer. Throughout the UK there has been a notable increase in the contribution to winter rainfall of heavy precipitation events. For the summer months, there is more regional variability, with some northern areas experiencing an increase from intense rainfall but other regions, notably South East England, experiencing a decrease. Extreme levels of rainfall led to severe flooding throughout the UK in summer 2007 and in Cumbria in November 2009.

Rainfall determines the availability of water in the environment to supply our customers and significant changes may constrain our ability to supply customers. Flooding events may threaten assets used to supply water to our customers.

2.1.3 Storminess

Severe windstorms have become more frequent in the UK in recent decades, although not above levels observed in the 1920s. This change may have been driven by natural climate cycles rather by anthropogenic climate forcing. Nevertheless, it is important to understand the risks associated and take adaptive action.

2.1.4 Sea Levels

Sea level around the UK rose on average by about 1mm/yr in the 20th century and the rate of sea level rise in recent decades has been higher than this.

Portsmouth Water's area of supply includes a significant proportion of coastline. Some of these areas are densely populated and consequently Portsmouth Water have significant assets sited on the coastline to supply these customers.

2.2 The Cost of Climate Change

Losses from extreme weather events are significant and expected to increase as the climate changes. The 2007 floods cost the UK economy over £3 billion, and caused £674 million of damage to critical national infrastructure. This lead to the commissioning of the Pitt Review 2008[2]. In 2006, the heatwave in the UK lead to disruption and loss of life across Durham and Cumbria. The heatwave experienced across Europe in 2003 resulted in 35,000 deaths and $15 billion in agricultural losses[3]. Insured losses from weather events currently cost the UK on average £1.5 billion a year[4].

Globally, increased temperatures will cause increased risk of water stress, species extinction, crop yield reductions, coastal flooding and disease.

Adaptation can reduce the costs of climate change, by avoiding both larger costs being incurred in the future and the risk of irreversible damage occurring. The Economics of Adaptation Working Group (2009)[5] found that for moderate amounts of warming, adaptation may reduce damages from climate change by 40-68%.

The infrastructure required to abstract, treat and distribute water has a large proportion of assets which are expected to be serviceable for periods in excess of 50 years. Consequently assets that are procured today need to be capable of operating efficiently in the differing climate conditions that are expected in the future. Failure to consider this will lead to increased replacement costs to the Company in future.

2.3 Policy Drivers

2.3.1 Pitt Review

A comprehensive report “Lessons Learned from the 2007 Floods” was prepared for Government by Sir Michael Pitt covering a whole range of issues relating to the floods. In total the report included 92 recommendations, several of which set out expectations of better resilience to flooding by the water industry.

2.3.2 The Climate Change Adaptation Report by Portsmouth Water Ltd Direction 2010 (“the Direction”)

Portsmouth Water has been directed to report on climate change risks and adaptation strategy to the Secretary of State.

2.3.3 Water Resources Management Plan Guidelines

Portsmouth Water are required to prepare a statutory Water Resources Management Plan which sets out how the Company intends to maintain the balance between demand and supply over the next 25 years. As part of this process water companies are required to assess the impacts of climate change on the supply demand balance.

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[2] Cabinet Office (2008) The Pitt Review: Learning lessons from the 2007 floods

[3] Cabinet Office – HM Treasury (2006) Stern Review on the economics of climate change

[4] Adaptation sub-Committee of the Committee of Climate Change (2010) How well prepared is the UK for Climate Change? First Report.

[5] Economics of Climate Adaptation Working Group (2009). Shaping climate-resilient development: a framework for decision-making.

2.3.4 Drought Planning Guidelines

Portsmouth Water have a statutory obligation to produce a Drought Plan on a three year cycle.

3. UNDERSTANDING CLIMATE RISK

3.1 UK Climate Projections 2009

In June 2009, the UK Government published the UK Climate Projections 2009 which provide probabilistic projections of future climate and climate change for UK territories up to the end of the twenty-first century, based on three possible global greenhouse gas emissions futures (known as the high, medium and low emissions scenarios).

The Projections tell us we can expect:

- Higher mean temperatures throughout the year
- Hotter peak summer temperatures
- Increased winter rainfall overall
- Increased rainfall on the wettest day of winter (more intense winter rainfall)
- Decreased summer rainfall overall
- Rising sea levels.

These changes will lead to increased risks from coastal flooding and erosion, and fluvial, groundwater and pluvial flooding. Changes in seasonal rainfall patterns may also lead to reduced groundwater yields and river flows and increased frequency of drought events. Hotter, drier summers may cause other social effects, such as health risks from very high temperatures, and economic change including increased tourism and changes to agriculture. Population migration and behaviour change may also result. All these social changes will impact upon demand for water.

3.2 Portsmouth Water Activities

Portsmouth Water is one of 22 water companies in England and Wales. It supplies an average of 180 million litres of water every day to a population of 660,000, together with 18,000 businesses, in an area of 868 square kilometres that straddles the border between Hampshire and West Sussex. The area of supply ranges from Fareham and Bishop’s Waltham in the west to Ford and Middleton-on-Sea in the east, and inland as far as the highest points of the South Downs. The majority of the population lives on the coastal plain in the urban areas of Fareham, Gosport, Havant, Waterlooville, Portsmouth, Chichester and Bognor Regis.

Portsmouth Water’s mission statement is “We aim to supply drinking water of the highest quality providing high levels of customer service and excellent value for money”.

To achieve this mission Portsmouth Water recognise the importance of long term strategic planning. Climate change is a long term risk to the business that has the potential to impact all activities in the business now and in the future. The Company is seeking to integrate the impacts of climate change in their strategic planning functions so operational activities will not be adversely impacted by climate change in the future.

The Company's day to day core operational activities involve collecting water from the environment, treating the water and transporting it to customers.

These activities are explained in more detail below.

3.2.1 Water Abstraction

Portsmouth Water have a total of 21 sites where we abstract water from the environment. Boreholes and wells account for 19 of the sites and an average of 50% of water supplied comes from boreholes and wells. The other two abstraction sites are from a group of natural springs accounting for 35% of the water supplied by the Company and a river abstraction which accounts for 15% of the water supplied.

All of the sources are groundwater fed from the chalk aquifer below the South Downs. Portsmouth Water's right to abstract water is granted in the abstraction licences issued by the Environment Agency. Portsmouth Water are currently undertaking a number of studies as detailed in the National Environment Programme to determine the impact if any of their abstractions on the environment.

The availability of water for abstraction is primarily dependent upon sufficient rainfall to recharge the aquifer.

The quality of the water abstracted from the aquifer is impacted by activities that take place in the catchment such as farming. Portsmouth Water works with stakeholders to influence parties carrying out activities in the catchment to improve the quality of the raw water.

The assets Portsmouth Water utilises for water abstraction are civil engineering ("civils") structures such as boreholes and buildings and mechanical and electrical (M and E) equipment for pumping the raw water from the source.

3.2.2 Raw Water Transportation

The majority of Portsmouth Water's abstraction sites have the water treatment process located at the same site. However a small number of sites have the treatment process at a different location. The raw water is transported from the abstraction point using a piped network through which water is pumped. The Company also operates three raw mains for nitrate blending. The assets associated with this operation have the potential to be impacted by a changing climate.

3.2.3 Raw Water Storage

Portsmouth Water has no significant raw water storage capacity. The River Itchen treatment works has bank side raw water storage which provides operational flexibility to deal with short term fluctuations of water quality on the river.

3.2.4 Water Treatment

Portsmouth Water has 19 water treatment sites, the processes vary according to the quality of raw water to be treated. Borehole sources of water tend to have better raw water quality, the springs with poorer water quality and the river source with the poorest raw water quality. The level of treatment is dependent upon the raw water quality, the poorer the water quality the more complex treatment required. The boreholes with the best raw water quality only requiring simple disinfection, ranging to multiple stage treatment at the River Itchen site. Climate change has the potential to impact the treatment process.

3.2.5 Potable Water Storage

The Company uses service reservoirs to store treated water. The service reservoirs are at 19 sites across the Company's area of supply, they provide the Company with the ability to manage short term fluctuations in demand and cope with operational incidents without impacting the service delivered to customers. Climate change has the potential to impact the ability of these assets to perform their function in the long term.

3.2.6 Potable Water Transportation

The Company uses a network of pipes to distribute the water from the treated water storage to the customers. Portsmouth Water has 3,266 km of water distribution mains used for this purpose. The pipes vary in age, diameter and material and are laid in a variety of ground types. The performance of the asset is measured by the number of asset failures or burst pipes that we experience each year. The future performance of the asset is likely to be impacted by climate change.

3.2.7 Customer Billing Function

The Company relies on the revenue from customers paying their bills to operate. The Company also requires the ability to communicate with their customers in both an emergency and under normal circumstances. These activities are undertaken by the customer department which is based in the Head Office in Havant.

3.2.8 Relationship with Stakeholders

Portsmouth Water recognises that effective strategic planning will only be successful if the appropriate stakeholders are involved in the process. Portsmouth Water has long standing relationships with its key stakeholders.

3.2.8.1 Regulatory and Governmental Bodies

Portsmouth Water has a number of regulators, Ofwat, Drinking Water Inspectorate, Consumer Council for Water, the Environment Agency and Natural England. It is paramount that a consistent methodology is developed to allow climate change to be incorporated into the planning framework and agreed upon by the regulators.

3.2.8.2 Customers

Portsmouth Water seeks to engage with their customers for a variety of different reasons. Alongside day to day interactions to deal with operational and billing matters, the Company also seeks to engage on strategic matters. The Company has undertaken customer research to inform the planning process. Another key aspect of customer engagement is carrying out research to understand and predict their future behaviour with regard to water use.

3.2.8.3 Local Authorities

Portsmouth Water seeks an ongoing dialogue with Local Authorities (LA) and respond to their planning consultations. This is an important area so that planning assumptions regarding water use made by Local Authorities, are appropriate and consistent with Portsmouth Water's plans.

3.2.8.4 Research and Industry Bodies

Portsmouth Water is a member of Water UK and UKWIR and through these organisations supports research into climate change impacts on the water industry. We also work with other bodies to broaden our understanding of the potential impacts of climate change.

3.2.9 Planning Horizons

Portsmouth Water produces a strategic direction statement which provides a 25 year high level long term plan. This plan is then used to set the context for a detailed 5 year Business Plan. Although the Business Plan details activities and investments that are undertaken in the next 5 years the options are appraised over a much longer planning period.

The 5 year Business Plan is normally consistent with the 25 year Water Resources Management Plan.

3.2.10 Attitude to Risk

Portsmouth Water's primary activity is essentially one of public health. This correctly results in a precautionary approach to risk.

3.2.10.1 Water Quality

The Drinking Water Inspectorate set a target of 100% compliance with the drinking water regulations. Portsmouth Water use a risk based approach to manage water quality in its Drinking Water Safety Plan. In 2009/10, the Company achieved 99.99% compliance.

3.2.10.2 Water Resources

The Water Resources Management Plan which details how the Company will manage the Supply/Demand balance uses a risk based approach to take account of uncertainty in the planning assumptions. The Company plans to supply water to customers only imposing restrictions on customers use on average of 1 in 20 years; ie a 5% risk in any year. This level of service was set through consultation with customers.

3.2.10.3 Resilience

Portsmouth Water plan that their operational sites should be resilient to a 1 in 100 year fluvial flood ie a 1% risk in any year, and be able to withstand a 1 in 200 year coastal flood.

4. DEFINING ADAPTATION

The Intergovernmental Panel on Climate Change defines adaptation as “any adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities”.

In infrastructure, this includes ensuring that new long-life assets are resilient to changes in temperature and precipitation and the increased recurrence of extreme events. It also includes changing systems and behaviour, working with stakeholders and building capacity.

The Adaptation Sub-Committee of the Committee on Climate Change (2010) stated that “the ultimate goal of adaptation is to reduce the costs and damages from Climate Change and enhance the opportunities”.

The Adaptation Sub-Committee published their first report on UK preparedness in September 2010. In it they identified two priorities for action:

1. Assets and institutions sensitive to current climate risks

2. Decisions with long lasting consequences.

The water industry is at the forefront of four out of the Sub-Committee’s five priority areas for immediate action; land use planning, national infrastructure, natural resources and emergency planning.

Proactive, as opposed to reactive, adaptation will be more cost-effective in mitigating risks and will also allow the identification and exploitation of opportunities.

5. METHODOLOGY

5.1 Rationale

Almost every aspect of UK life will be impacted in some way by climate change. This is significant for Portsmouth Water because the Company assets are long term and decisions taken now will have consequences for many years. Understanding how climate change will impact upon the business, our stakeholders and our organisational objectives will allow existing and emerging risks to be identified and prioritised for action. This will enable adaptation to be built in to our internal planning and risk management processes.

Preparing for climate change proactively will reduce costs and allow the identification of opportunities. It allows flexibility in adaptation to be maintained, avoiding reflex, reactive adaptation and lock-in to a single adaptation response.

5.2 Approach

The assessment takes an organisational, rather than solely site-specific approach, considering both asset-level and business-level risks in terms of how these may impact the delivery of our business functions.

This includes considering impacts upon our assets, plans and operations as well as impacts on our customers and stakeholders. Specifically, this draws on a twin-track, iterative approach of:

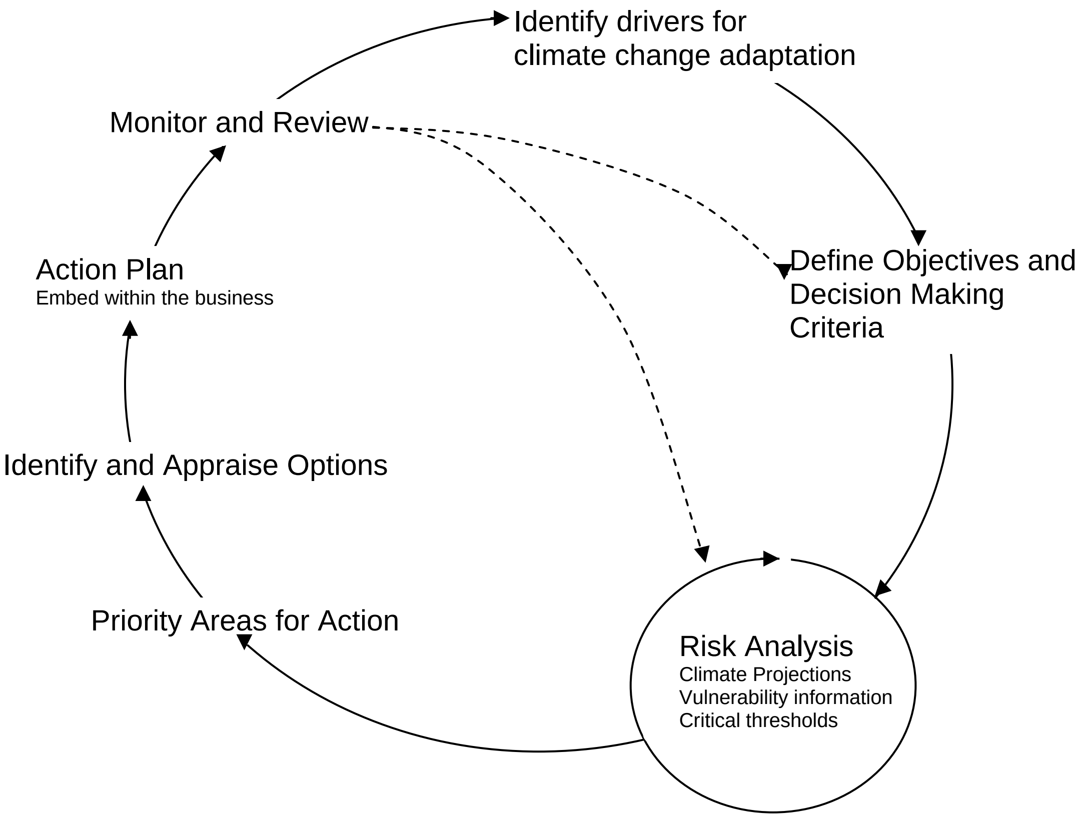
- Considering the current and future vulnerabilities of the Company's assets and operations to aspects of climate and weather
- Considering the Climate Projections in detail and identifying how a changing climate may impact upon the business.

5.3 Overall Methodology

Our methodology is adapted from the UKCIP, Environment Agency and Defra 2003 framework[6] in order to align with the Company's existing planning and risk management processes. This is illustrated in the figure below.

[6] UKCIP, Defra and Environment Agency. 2003. Climate Adaptation: Risk, Uncertainty and Decision-Making.

Portsmouth Water's Climate Change Adaptation Framework



Identifying Drivers

Drivers for adapting to climate change include statutory duties to maintain safe, reliable water supplies.

Define Objectives and Decision-Making Criteria

Objectives are determined by the Company's aims and missions and assessed by business function. Decision-making criteria bring together those utilised in the Company's existing risk management mechanisms.

Priority Areas for Action

Priority areas for action are determined from aggregated risks and interdependencies.

Identify and Appraise Options

Options are identified and appraised according to financial and socio-economic criteria and the risk reduction achieved.

Action Plan

The Action Plan will embed adaptation actions in to the Company's existing risk management mechanisms.

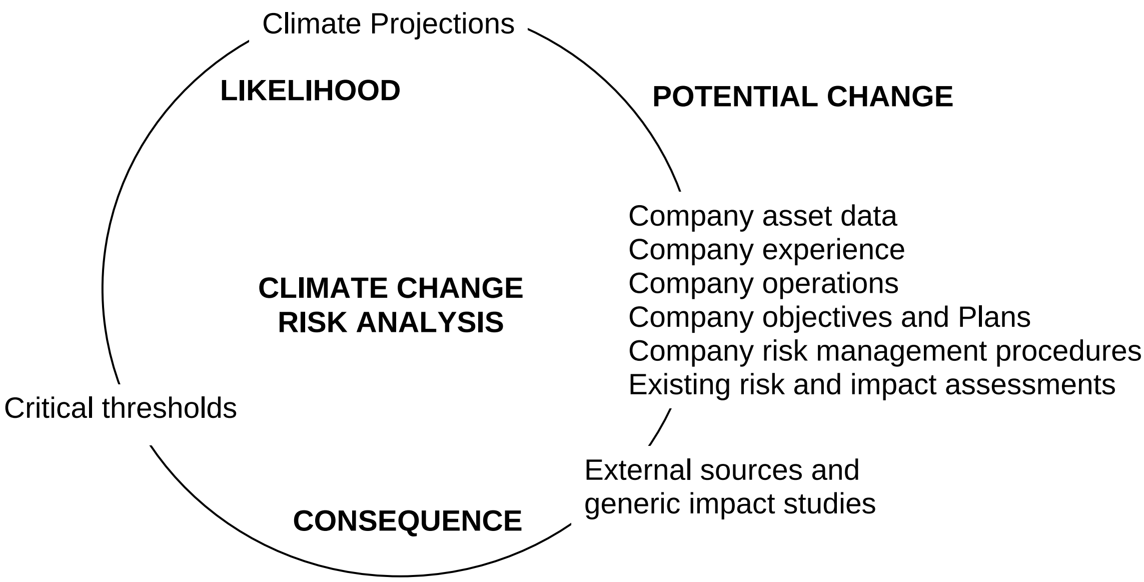
Monitor and Review

Mechanisms for monitoring critical thresholds and residual risk are identified, and mechanisms for future review to identify success and barriers to implementation.

5.4 Climate Change Risk Assessment Methodology

The risk assessment methodology is an iterative process, bringing together an understanding of the range and uncertainty of possible future climate from the Climate Projections with detailed information on the Company's assets, past experience, operations, objectives, risk management procedures and plans. The Company already has an appreciation of the types of impacts we can expect from climate change. For example, the Company has included climate change impacts in our Water Resources Management Plan, and has undertaken a Flood Resilience Assessment which has led to practical improvements at key sites. Understanding of some impacts, such as those on the water supply-demand balance, is necessarily more comprehensive than understanding of other impacts.

This analysis builds upon past work to identify and assess climate change risks in a coherent way and to quantify risks using a common framework. The figure below illustrates the process.



In detail, the components of this process are as follows:

5.4.1 Review the UK Climate Projections 2009 in detail for our area

Develop a comprehensive understanding of the possible climates we may be exposed to in the future according to current science, including an appreciation of the probability, uncertainty and limitations of the Projections. Once critical thresholds have been identified from Company data, likelihood and certainty by a given point in time can be determined from the Projections.

5.4.2 Company Information

The Company information this risk assessment draws upon includes the following:

- Company asset data
- Company operational activities
- Company past experience of climate and weather vulnerabilities

- Company strategic objectives and Plans, including:
  - Portsmouth Water Strategic Direction Statement
  - Portsmouth Water Water Resources Management Plan

- Company risk management procedures and Plans, including:
  - Drinking Water Safety Plans
  - Business Continuity measures
  - Emergency Plan
  - Drought Plan

- Existing risk assessments including:
  - Flood Resilience Assessment 2009

- Portsmouth Water Final Determination 2009

- Business engagement with planning, operations and management personnel specific to this assessment

5.4.2.1 External sources and generic assessment

To carry out this assess the Company draw upon a number of external climate change impact studies including:

- Adaptation Sub-Committee of the Committee on Climate Change (2010) How well prepared in the UK for climate change?

- AEA (2010) Adapting the ICT Sector to the Impacts of Climate Change

- Cabinet Office (2010) Sector Resilience Plan for Critical Infrastructure 2010

- Chatham House and Global EESE (2009) The Vulnerability of Energy Infrastructure to Environmental Change

- Defra (2010) Engineering, Infrastructure and Climate Change Adaptation Conference: Engineering to ensure long-term climate resilient infrastructure. Report of Proceedings 1st December 2009, The Royal Society, London

- Environment Agency (2009) Test and Itchen Catchment Flood Management Plan

- Environment Agency (2009) climate change, adapting for tomorrow

- Environment Agency (2009) Arun and Western Streams Catchment Flood Management Plan

- Highways Agency (2009) Climate Change Adaptation Strategy and Framework – Revision B

- HM Treasury (201) National Infrastructure Plan

- MWH (2007) Water UK: A Climate Change Adaptation Approach for Asset Management Planning 41414874 V1.0

- Pricewaterhouse Coopers LLP (2010) Adapting to Climate Change in the Infrastructure Sectors

- Royal Commission on Environmental Pollution (2010) Adapting Institutions to Climate Change

- UK Climate Impacts Programme (2005) Measuring progress: preparing for climate change through the UK Climate Impacts Programme.

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- URS (2010) Adapting Energy, Transport and Water Infrastructure to the Long-term Impacts of Climate Change, RMP/5456.

5.4.4 Business Functions

Risks are assessed against the following business functions:

5.4.4.1 Supply Business Function

The supply business function is comprised of three activities; the water resources activity, the abstraction activity and the raw water quality activity.

Water Resources Activity

The water resources activity is the process of strategically managing the supply/demand balance and preparing the statutory 25 year Water Resources Management Plan.

Abstraction Activity

The abstraction activity is the operational activity of sourcing water of sufficient quality and in sufficient quantity, and has a number of assets associated.

Raw Water Quality Activity

The raw water quality activity is the process of managing water quality risks in our raw supplies which arise due to other catchment operators and hydrogeological properties of the region.

5.4.4.2 Raw Transportation Business Function

Raw transportation is the function of transporting raw (untreated) water, either for nitrate blending purposes or to a treatment works.

The function has a number of assets associated such as pumps and mains.

Water quality risks which arise in the raw transportation stage are included here as this is in line with our Drinking Water Safety Plan (DWSP) methodology.

5.4.4.3 Raw Storage Business Function

The Company has very limited raw water storage facilities. This function is limited to a single concrete structure located on site at one treatment works.

Water quality risks which arise at this stage are included here as this is in line with our DWSP methodology.

5.4.4.4 Treatment Business Function

Treatment is the process of treating water to potable standards through mechanical and chemical means, and has a number of assets associated.

Water quality risks which arise at this stage are included here as this is consistent with our DWSP methodology.

5.4.4.5 Potable Storage

Potable storage is the process of storing water in service reservoirs from which water feeds to the customers' tap.

Water quality risks which arise at this stage are included here as this is consistent with our DWSP methodology.

5.4.4.6 Potable Transport

Potable transport is the process of transporting water from a treatment works to a service reservoir, and from the service reservoir to the customers' tap.

The function has a number of assets associated.

Water quality risks which arise at this stage are included here as this is in line with our DWSP methodology.

5.4.5 Quantifying Risk

Risk is quantified according to existing Company procedures, where 'risk' is determined from a measure of consequence and likelihood, as follows:

Risk = Consequence X Likelihood

The assessment of consequence and likelihood is quantitative, using a scoring methodology from 1 to 5 as defined in the table below.

Risks were assessed in the Near (0-30 years), Medium (30-60) years and Long (60+ years) term.

These risk rankings were adapted from existing risk rating methodologies used across the business, within the Drinking Water Safety Plan, capital maintenance planning, water resources planning and resilience assessment.

This enables, for example, climate change risks on different aspects of the business to be compared. As this risk assessment was strategic in nature, where necessary we put a value (consequence score) on the increase in risk of a given pressure driven by climate change. This is particularly the case when assessing risk associated with extreme events with a given return period, such as floods and storms. As the return period decreases, and risk increases, we score the consequence to provision of service of operating under higher flood or storm risk overall, rather than assessing the impacts to a site of a flood or storm event. This alone would not reveal the risks to service provision, due to network connectivity and other resilience measures the Company has in place to protect supplies.

Score	**Likelihood** of critical threshold being exceeded	**Consequence Score** if critical threshold exceeded	**Consequence** for service (Water Resources and Abstraction)	**Consequence** for service (Water Quality)	**Consequence** for asset and environment.	**Consequence** for Company
1	Very low / Negligible (1 in 1000)	Negligible	Negligible	Negligible	Negligible	Negligible
2	Unlikely (1 in 100)	Minor (low)	Moderately affecting source of normal daily output maximum of <=20 Ml/d	Aesthetic impact for 1 consumer	Minor environmental impact. Minor asset loss.	Minor financial costs incurred. Minor disruption.
3	Moderately likely; 50/50 (1 in 50)	Moderate	Significantly affecting source of normal daily output maximum of <=20 Ml/d. Moderately affecting source of normal daily output maximum of 20-40 Ml/d.	Aesthetic impact for up to 10 consumers Up to 10 discoloration contacts Up to 2 taste and odour contacts	Moderate environmental impact. Moderate asset loss.	Moderate financial costs incurred. Moderate disruption.

4	Highly likely (1 in 10)	Significant (high)	Significantly affecting source of normal daily output maximum of 20-40 Ml/d. Moderately affecting source of normal daily output maximum of >40Ml/d	Potential health related impact for up to 10 customers. Aesthetic impact up to 1000 customers. Over 50 discoloration contacts. 5 or more taste contacts. Actual multiple failures of one or more standards.	Significant environmental impact. Significant asset loss.	Significant financial costs incurred. Significant disruption.
5	Inevitable (Once a year)	Major (very high)	Significantly affecting source of normal daily output maximum of >40 Ml/d	Potential health related impact for more than 10 customers. Aesthetic impact for over 1000 customers. Actual multiple failures of one or more standards.	Extensive environmental impact. Major/critical asset loss.	Major financial costs incurred. Major disruption.

5.4.6 Critical Thresholds

From this process, critical thresholds of climate impacts are identified where applicable and practicable.

For some aspects a critical threshold can be clearly identified because there is little interconnectivity with impacts of other climate variables and impacts on other company activities or stakeholders. For other aspects however, critical thresholds are much more difficult to determine. This is especially the case in water resources planning, where the impacts of climate change are incremental but the criticality of an individual impact depends upon interactions and impacts elsewhere.

Once critical thresholds have been identified, the probability of exceedence of the threshold can be determined from the Climate Projections.

5.4.7 Certainty

Confidence in each assessment is rated qualitatively as **high, medium and low** and any assumptions made are clearly stated.

5.4.8 Findings

Results are presented in a risk table for each business function in Section 7. In Section 8 of this report, all risks are brought together and presented in a risk matrix to allow risk prioritisation and the identification of priority areas for action.

5.5 Adaptation Planning Methodology

5.5.1 Priority Areas for Action

Risks are prioritised according to the outcomes of the risk assessment, which assessed the consequence and likelihood of each risk to the Company's functions. High scoring risks, high uncertainty-high consequence outcomes and interconnectivities indentified in the risk assessment define the priority areas for action.

Priority areas for action are grouped according to the lead time of the critical impact, i.e., whether they are near (0-30 years), medium (30-60 years) or long (60+ years) term risks.

5.5.2 Decision Making Criteria

Options for risk management are identified and those already being undertaken are described. The decision making criteria for appraising options, based on the priority areas of action, are defined as follows:

(1) Lead time of critical impact
Whether this is a near (0-30 years), medium (30-60 years) or long (60+ years) term risk

(2) Lead time of response
The time taken for a particular response to be implemented, assessed as short (< 1 year), medium (1-5 years) or long (5+ years). For example, changes to operational procedures can be implemented relatively quickly (<1 year), whereas capital scheme responses may take several years.

(3) Cost of action
The financial cost of the response, and where appropriate, the social and environmental costs assessed using mechanisms such as the shadow price of carbon.

(4) Benefit of action
The benefit of undertaking the response; incorporates a measure of the risk reduction and any additional benefits of the proposed measure, if applicable.

(5) Certainty
Certainty in the risk assessment findings was assessed as low, medium and high.

Many of our adaptation actions and plans are simply commitments to incorporate climate change risks in to future decisions, in order that climate change adaptation planning is embedded within risk management and planning mechanisms for water resources, water quality, capital maintenance and investment, and resilience and emergency planning.

5.5.3 Adaptation Plan

The Climate Change Adaptation Action Plan must support sustainability principles and be viable in a low carbon economy. The Plan will also be subject to monitoring and review.

6. ANALYSIS OF UK CLIMATE PROJECTIONS

This section of the report summarises our detailed assessment of the UKCP09 data, identifying the climate variables, probability and risk levels, and key time horizons that are relevant to our planning and activities.

The key climate variables of relevance to our activities are:

- sea level rise, for saline intrusion of aquifers and risk to our coastal assets
- precipitation change (annual, winter, summer, August, peak intensity), for aquifer recharge, demand for water, secondary water quality effects, flood risk
- temperature change (winter, summer, August, peak and minimum temperatures), for aquifer recharge, demand for water, water quality, asset performance, asset deterioration
- cloud cover (summer), for raw water quality
- storminess, for asset security and supply chain risks

The relevant planning horizons for Portsmouth Water are principally:

- 25 years, for the Water Resources Management Plan (supply-demand balance impacts)
- 25 years for our Strategic Direction Statement
- 60+ years for options appraisal of capital and operational options for managing the supply-demand balance
- 50+ years when developing new civils assets

This section therefore principally discusses the Projections for the 2030s (2020-2049) and the late Century (2080s, 2070-2099).

6.1 <u>Sea Level Rise</u>

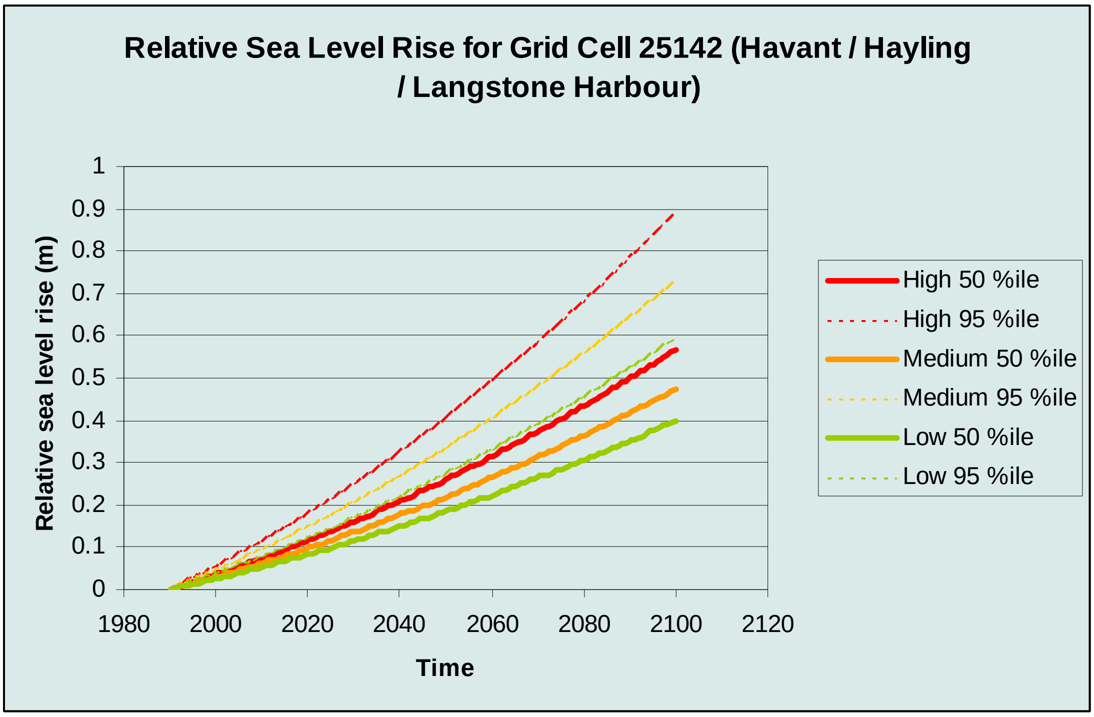
Sea level around the coast of the UK has risen by approximately 1mm per annum in the 20th century and the rate of sea level rise has accelerated in the latter part of the century.

Projections for relative[7] sea level rise for the for the 21st century show a central estimate of 0.47m under the medium emissions scenario for Portsmouth Water's area[8] by the end of the century. Approximately 17% (0.08m) of this is driven by vertical land movement from glacial isostatic adjustment. The sea level rise resulting from global climate change is modelled from both thermal expansion of the oceans and glacial melt. The 95th percentile (95% probability of non-exceedence) under the high scenario shows a rise of 0.89m.

The figure below shows the 50th and 95th percentiles for the sea level projections under the three emissions scenarios.

[7] Relative, as opposed to absolute, sea level rise also takes in to account vertical land movement.
[8] UKCP09 Grid Cell ID 25142 (covering Havant / Hayling Island / Langstone Harbour) has been chosen as the representative point for sea level rise in Portsmouth Water's area.

UKCP09 also included a “High plus plus (H++)” scenario for sea level rise. This extreme estimate of sea level rise ranges from 0.93-1.90m by 2100 although it must be noted that the probability of such a rise occurring this century is considered to be very low and the scenario was produced for the purposes of contingency planning.



Coastal change will impact upon a number of Company activities. For example, sea level rise and costal erosion could result in the loss of Company assets at the coast. The criticality of this for service provision depends upon the asset affected.

Sea level rise may also cause saline intrusion of groundwater and cause rising salinity at our river source works due to the estuarine zone moving upstream.

Population migration away from areas at risk of coastal change may also occur. This may affect local demand for water and require changes to the distribution network and water resources. The policies of planning authorities on shoreline management will be important for spatial planning.

More broadly, the Company will need to accommodate uncertainty in the stability of the shoreline in our long-term planning.

Impacts of sea level rise are assessed in more detail in the risk assessment.

6.2 Precipitation

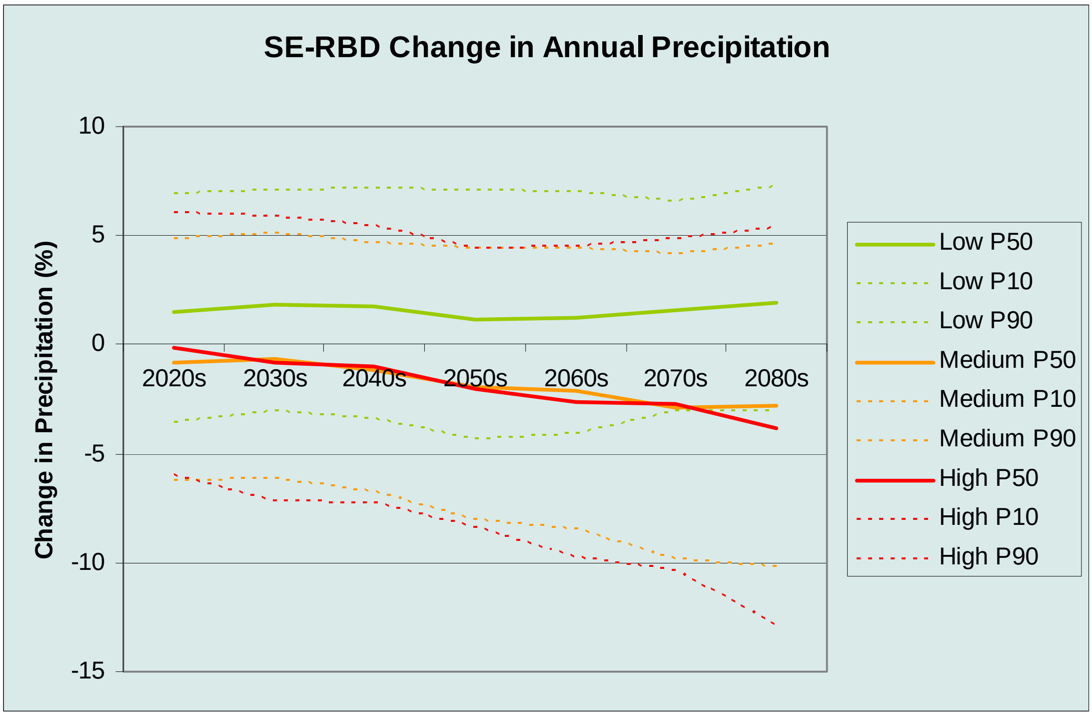
The data presented in this section is averaged over the South East River Basin District area, defined for EU Water Framework Directive delivery. Climate change projections are used, as opposed to absolute projected climate values, and shown as plume plots presenting the forecast over time. In all graphs, the central estimate (50th percentile, P50) is shown as a solid line, and the 10th (P10) and 90th (P90) percentiles (signifying 90% probability of non-exceedence) are shown as dashed lines. These values have been selected to reflect Portsmouth Water's precautionary approach to risk, whilst recognising UKCIP's caution against using data beyond the 10th and 90th percentiles, due to increased uncertainty in the data at the tails of the probabilistic distribution.

Change in precipitation patterns will impact upon a number of the Company's existing activities, such as:

- Water resources: source yield, demand for water, recurrence of drought.
- Flood risk: (fluvial groundwater and pluvial) to assets that may affect the abstraction, treatment, storage and transportation of water
- Water quality: increased turbidity caused by runoff from intense rainfall events, lower river flows causing increased concentration of pollutants

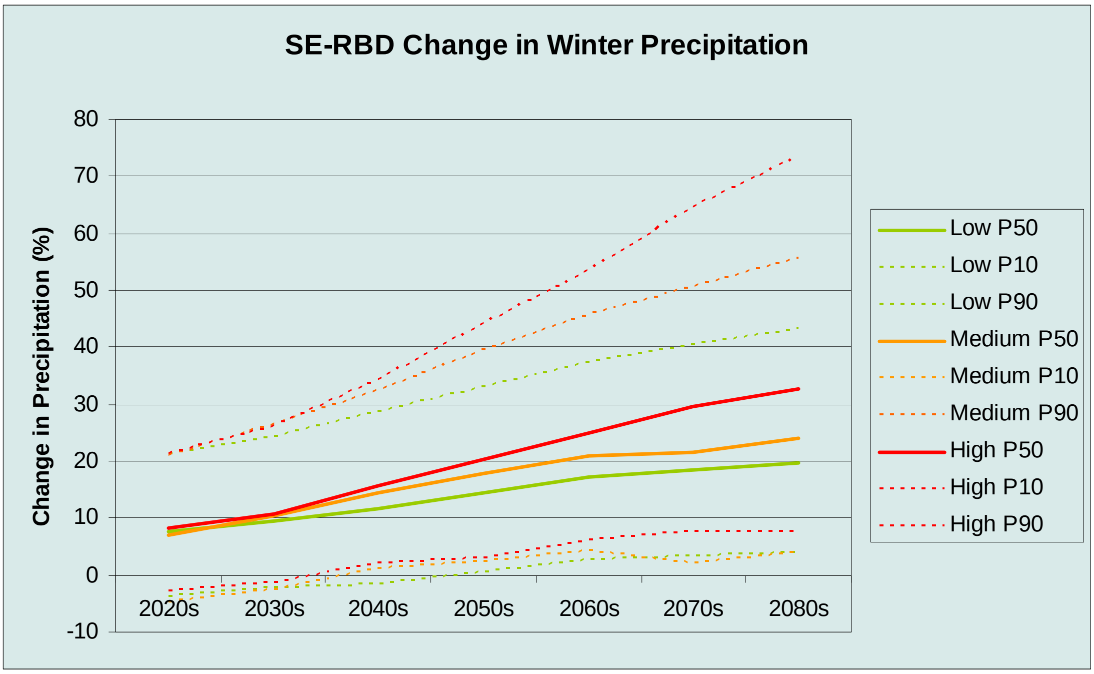
6.2.1 Projected Change in Annual Precipitation

The Projections show no significant change in mean annual precipitation by the end of the Century at the central estimate, with a range of +2% to -4% depending upon emissions scenario. At the most extreme, the 10th percentile under the high emissions scenario shows up to a 13% reduction, whereas the 90th percentile projections are relatively flat at a 5-7% increase.



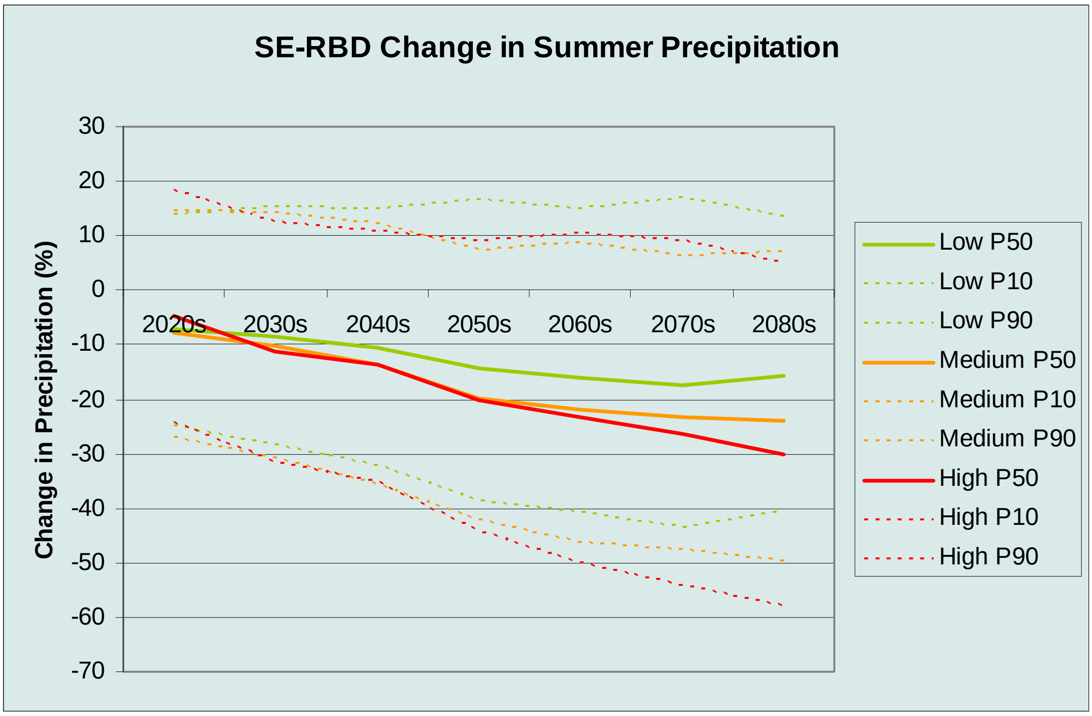
6.2.2 Projected Change in Winter Precipitation

Projections of change in climate are more marked when the data is examined at the seasonal level. For winter precipitation, all emissions scenarios show an increase at central estimate and the 10th and 90th percentiles, all the 10th percentile shows only a marginal impact. The increase is likely to be approximately 10% by the 2030s and 20-32% by the end of the Century (all scenarios, P50 values). The 90th percentile under the high emissions scenario shows a change of 25% by the 2030s.



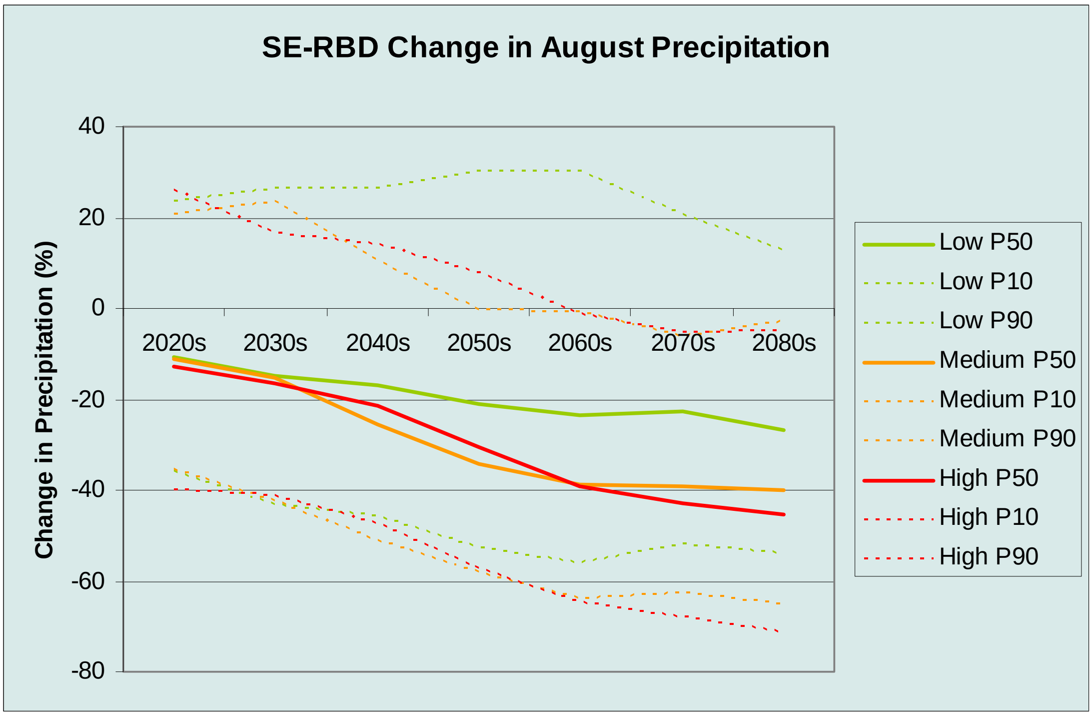
6.2.3 Projected Change in Summer Precipitation

For summer precipitation, all emissions scenarios show a decrease at the central estimate. For the 2030s, the Projections are similar for all scenarios showing approximately 8% to 12% reduction (P50). The P10 values show a 27% to 33% reduction whereas the P90 values are relatively flat at a 15% increase. Central estimates for the 2080s are from -15% to -30%. Reductions in summer precipitation will impact both aquifer recharge and therefore source yields, and demand for water. Lower river flows could also cause pollutants in the river to become more concentrated and present a water quality risk. Lower groundwater levels could also combine with the effects of sea level rise to increase the risk of saline intrusion.



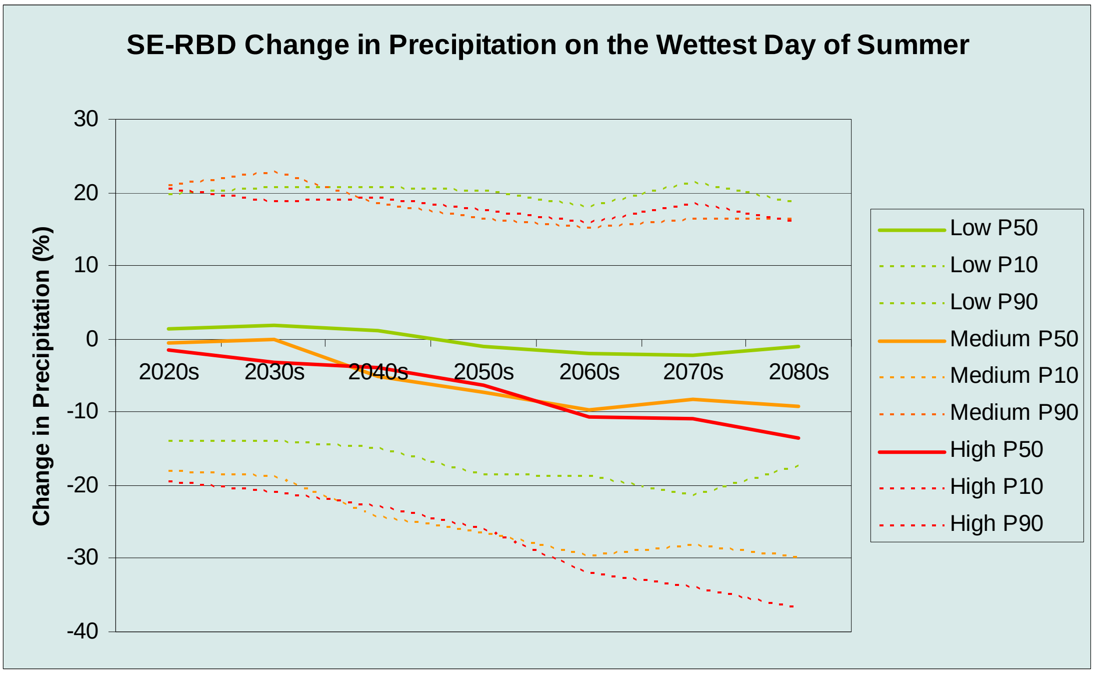
6.2.4 Projected Change in August Precipitation

For the August data, the projected reduction in precipitation is even more marked, showing central estimates of -14% to -16% in the 2030s, with P10 values of over -40%. By the end of the Century, reductions in August precipitation could be as large as 70% (high emissions scenario, P10), although conversely P90 values show little net change. Central estimates for the 2080s are from a 26% to a 45% decrease, and up to 70% at P10 (high scenario). Reductions in August precipitation will impact both aquifer recharge and therefore source yields, and demand for water. Lower river flows could also cause pollutants in the river to become more concentrated and present a water quality risk. Lower groundwater levels could also combine with the effects of sea level rise to increase the risk of saline intrusion.



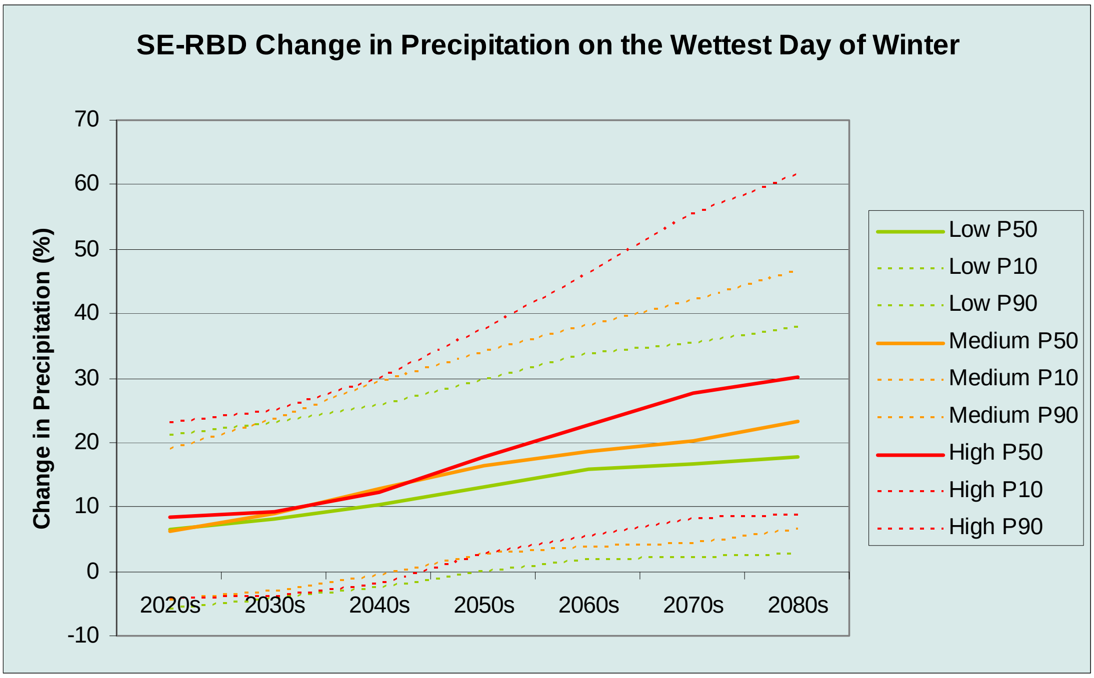
6.2.5 Projected Change in Precipitation on the Wettest Day of Summer

Precipitation on the wettest day of summer is not expected to change significantly by the 2030s. Projections show up to a 13% reduction (high emissions scenario) at the central estimate by the end of the Century.



6.2.6 Projected Change in Precipitation on the Wettest day of Winter

The Projections forecast an upward trend in the amount of precipitation falling on the wettest day of winter. Central estimates forecast up to 10% more rainfall on the wettest day by the 2030s, and 30% more by the end of the Century for the central estimate. P10 to P90 show a range varying from negligible change to over 60% increase by the 2080s. The intensity of the rain will impact aquifer recharge, and therefore source yield, and also affect flood risk both at our assets and more widely across the Company's operational area. This could cause an interruption to normal operations during a flooding event, and in the longer term cause local to regional scale population migration out of the floodplain and away from other areas at risk of flooding. It may also increase raw water quality risk from surface water runoff in areas where this is already a problem.



6.3 Temperature

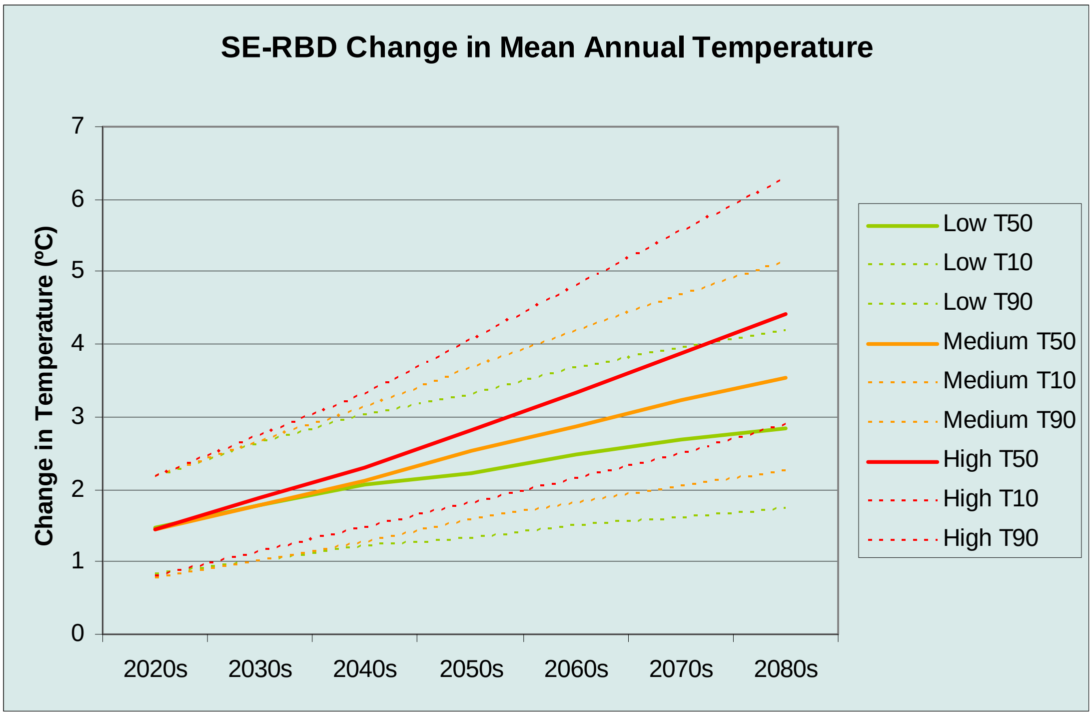
The data presented in this section is averaged over the South East River Basin District area, defined for EU Water Framework Directive delivery. Climate change projections are used, as opposed to absolute projected climate values, and shown as plume plots presenting the forecast over time. In all graphs, the central estimate (50^{th} percentile, T50) is shown as a solid line, and the 10^{th} (T10) and 90^{th} (T90) percentiles (signifying 90% probability of non-exceedence) are shown as dashed lines. These values have been selected to reflect Portsmouth Water's precautionary approach to risk, whilst recognising UKCIP's caution against using data beyond the 10^{th} and 90^{th} percentiles, due to increased uncertainty in the data at the tails of the probabilistic distribution.

Change in temperature patterns will impact upon a number of the Company's existing activities, such as:

- water resources: regional evapotranspiration and therefore source yield, and demand for water (including seasonal tourist population)
- water quality: chlorine depletion rate in treated water, biological and bacterial growth
- high ambient temperatures may impact operating efficiency of mechanical and electrical equipment
- extreme heat wave events may cause road-melt and impact operations
- an increase in temperature on the coldest day/night of winter, and a reduction in frost days, may have a positive impact on pipe burst rates

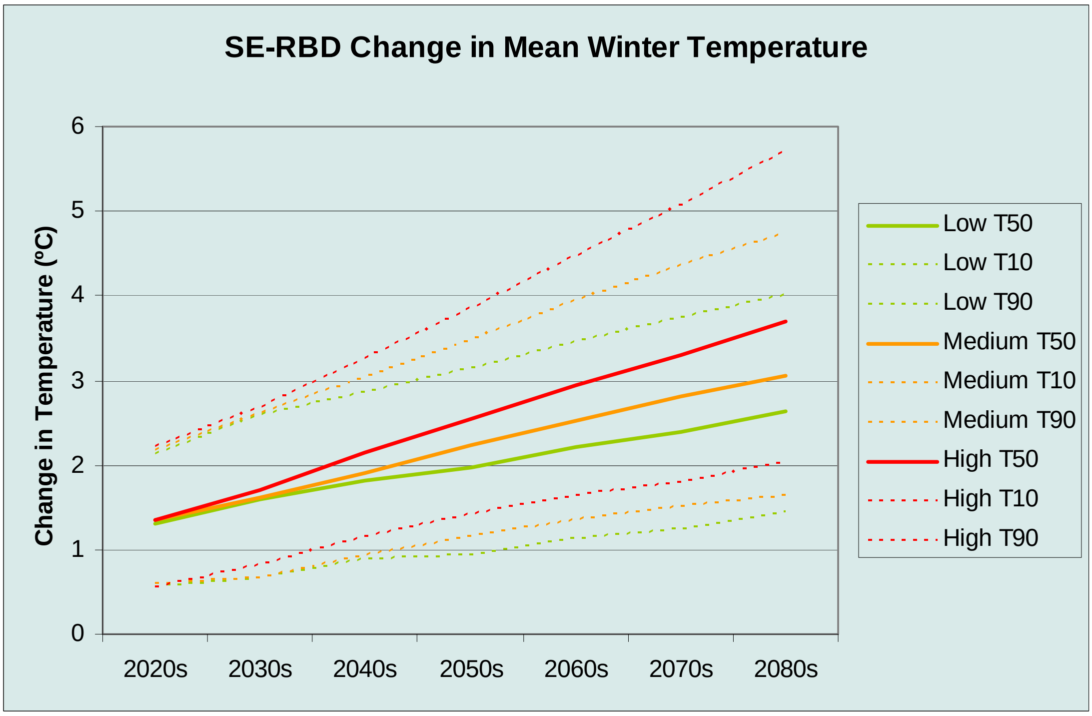
6.3.1 Projected Change in Mean Annual Temperature

All scenarios show a rise in mean annual temperature at the central estimate as well as the 10^{th} and 90^{th} percentiles. For the 2030s, Projections show that warming will not exceed 2ºC at the central estimate, and that the warming will be between 1ºC and 2.8ºC with 90% certainty (T10 and T90). Towards the end of the Century, central estimates for the three emissions scenarios diverge, ranging from around +2.8ºC to +4.4ºC at the central estimate.



6.3.2 Projected Change in Mean Winter Temperature

Mean winter temperature is expected to rise between 1.6-1.8ºC by the 2030s (central estimate, all emissions scenarios) and by 2.6-3.6ºC by the end of the Century. T10 and T90 values are +0.6ºC and +2.7ºC for the 2030s.

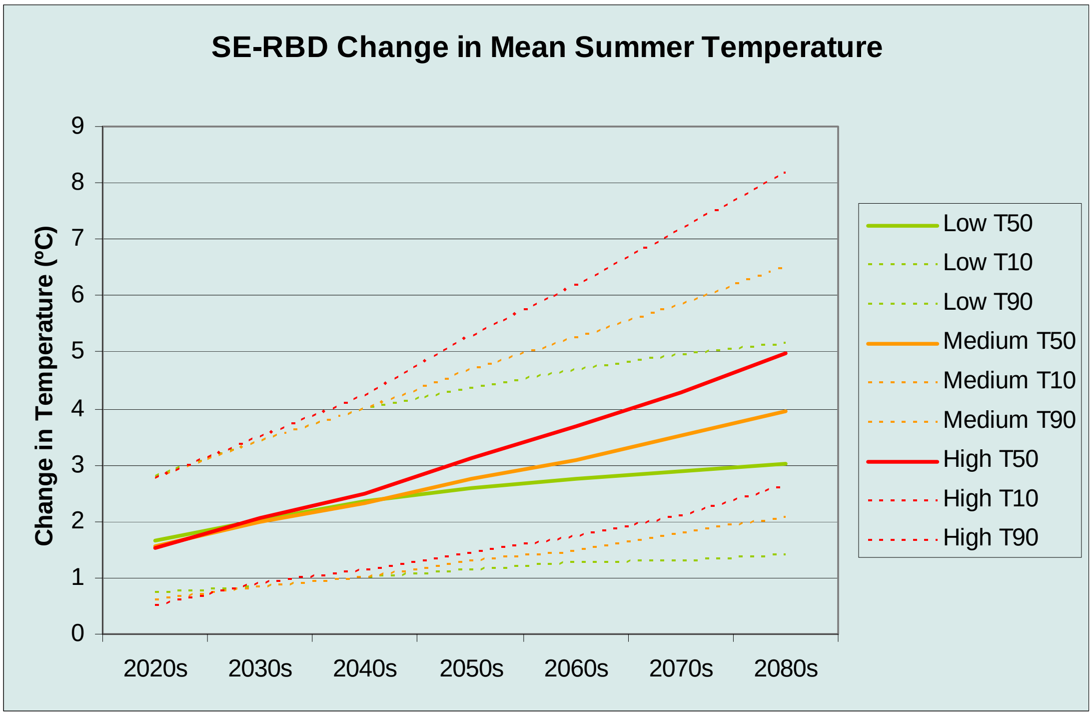


6.3.3 Projected Change in Mean Summer Temperature

Mean summer temperature is expected to rise by approximately 2ºC at the central estimate for all scenarios by the 2030s. The T10-T90 range is a 0.8-3.5ºC rise. By the end of the Century, central estimates are from +3ºC to +5ºC at the central estimate. Changes in summertime temperatures will impact upon demand for water, including through lifestyle changes of the permanent population and though the potential increase in seasonal (e.g. tourist) population. The availability of water may also be affected due to changes in evapotranspiration rates in the catchment.

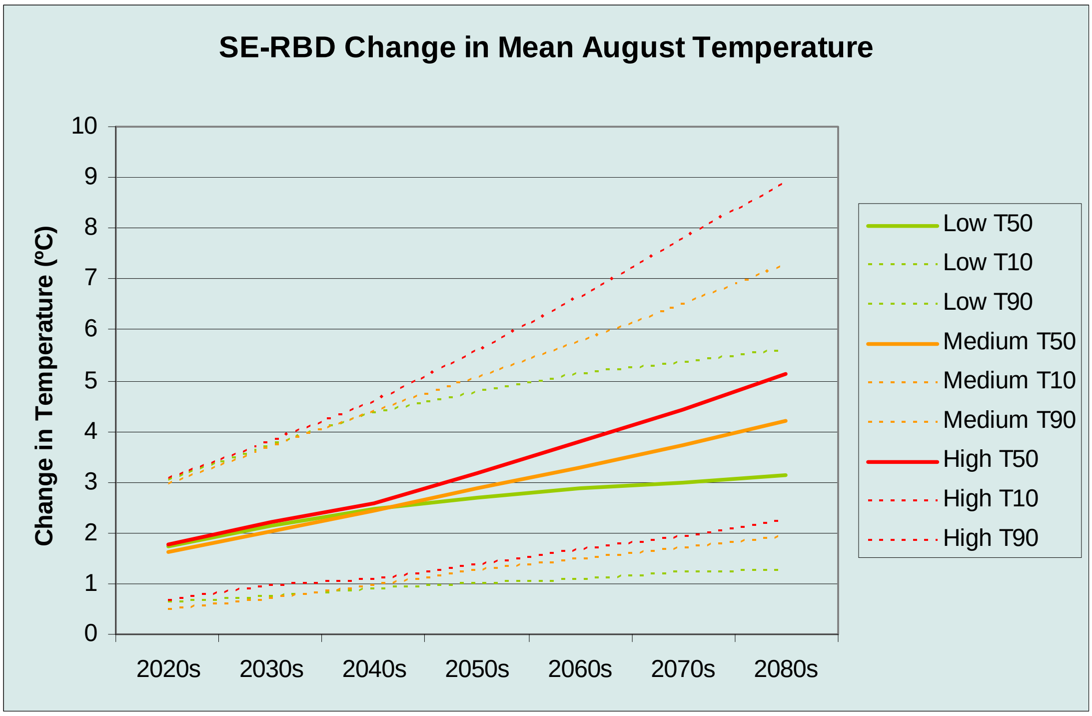
The impact of warmer summers leading to increased tourism will cut across multiple aspects of the business including water resources, potable transportation and distribution.

More extreme wetting and drying cycles will also impact asset deterioration.



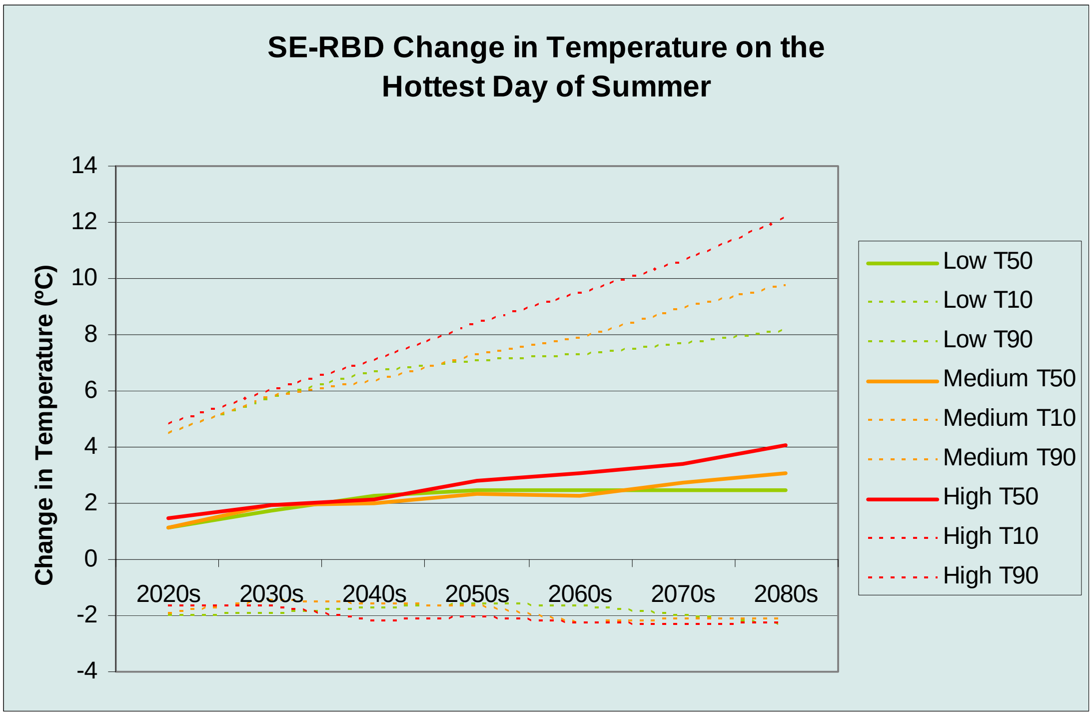
6.3.4 Projected Change in Mean August Temperature

Mean temperatures in August are expected to rise by over 2ºC by the 2030s and by just over 3-5ºC by the end of the Century (central estimates, all scenarios). T90 values are approximately 3.8ºC for the 2030s and 5.6-9ºC for the 2080s. T10 values are much lower, only exceeding a 2ºC rise in the 2070s. An increase in temperature during August may impact the demand for water through lifestyle change and a seasonal influx of consumers due to tourism. August temperatures are also generally the hottest of the year and are therefore important when assessing the impact of temperature rise on the operating efficiency of our mechanical and electrical assets.



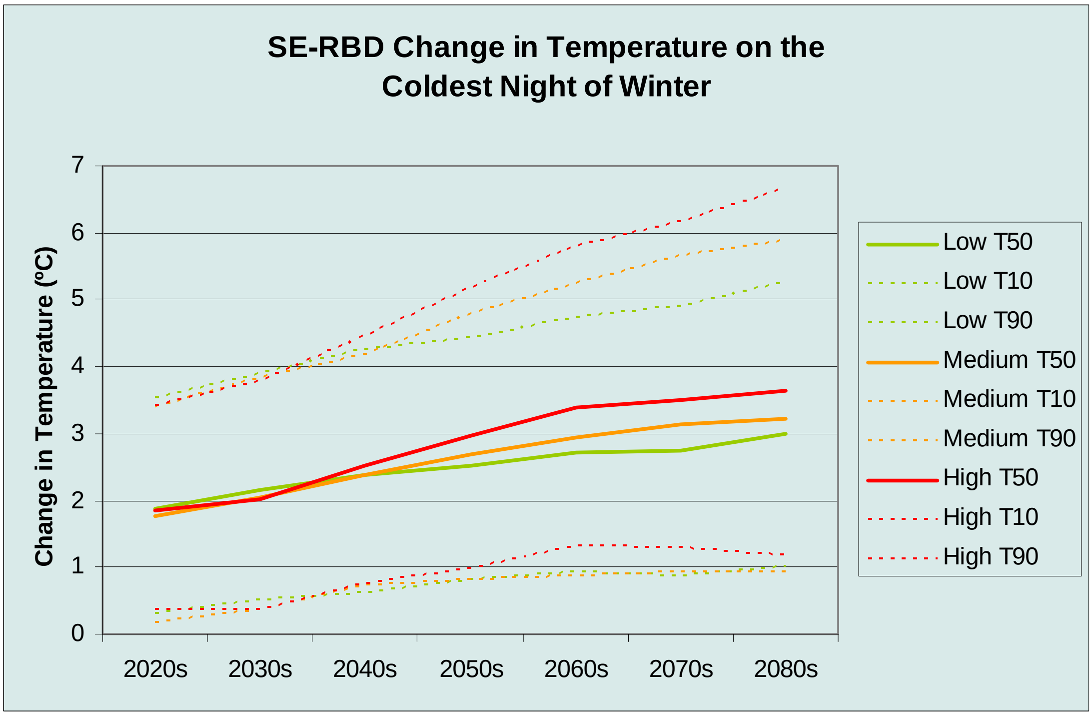
6.3.5 Projected Change in Temperature on the Hottest Day of Summer

The temperature on the hottest day of summer is expected to be just under 2ºC warmer by the 2030s (central estimates). Under the low emissions scenario there is projected to be little further change beyond this, although under the high emissions scenario the increase reaches 4ºC by the 2080s. T10 values are approximately -2ºC throughout the Century. T90 values rise sharply from 4.5-5ºC in the 2020s to up to 12ºC in the 2080s (high scenario). A rise in temperature on the hottest day of summer may lead to impacts on peak demand for water and also indicate the increased risk of heat waves, leading to road melt, which may temporarily impact upon operations.



6.3.6 Projected Change in Temperature on the Coldest Night of Winter

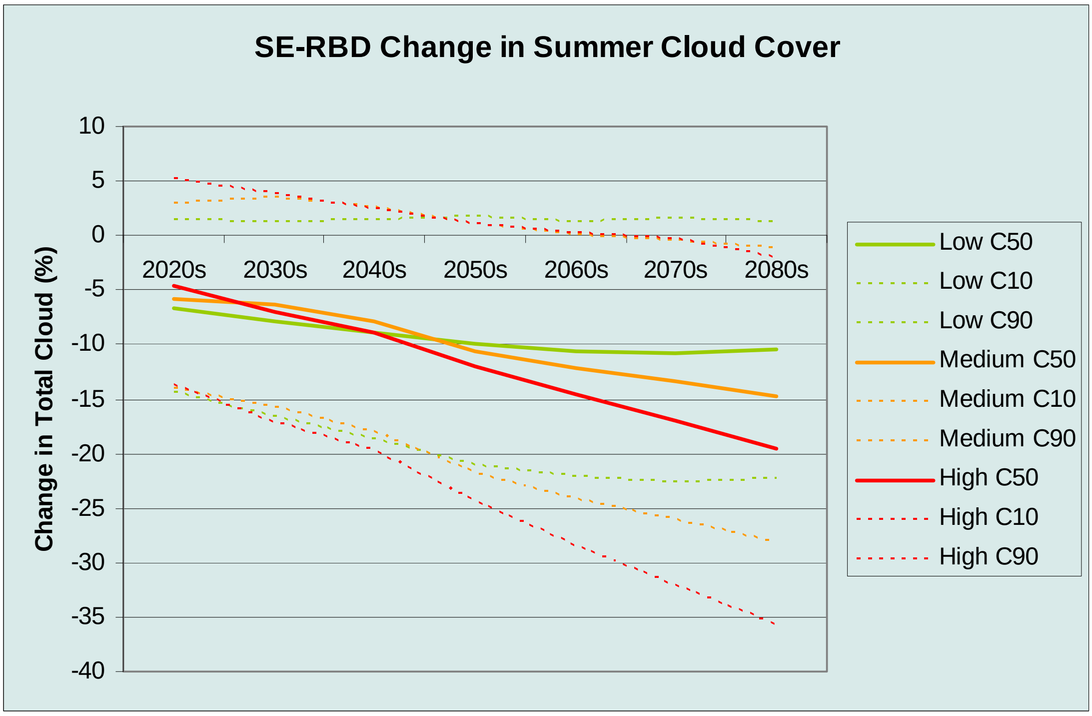
The temperature of the coldest night of winter is expected to rise by 2ºC by the 2030s and 3ºC or more by the 2080s (central estimate figures). Combined with increased mean winter temperatures overall and UKCIP's projections of reductions in the number of frost days, this could lead to a reduction in the number of burst mains associated with cold weather.



6.4 Cloud Cover

6.4.1 Projected Change in Summer Cloud Cover

Projections show that we can expect a 6-8% reduction in summer cloud cover by the 2030s at the central estimate, reaching 10-20% by the 2080s (depending upon emissions scenario). Reduced cloud cover and the resulting increase in sunlight received may cause an increase in organic growth in surface water sources and raw water storage and treatment assets.



6.5 Storminess

The UK Climate Impacts Programme forecast an increase in the frequency and severity of storms. This may impact Company telecommunications and operations.

7. CLIMATE RISKS BY BUSINESS FUNCTION

This section of the report sets out the Company's strategic climate risks presented by business function, supply, raw transport, raw storage, treatment, potable transport and potable storage.

In practical terms, providing our customers with water supplies is an integrated process. Measures we undertake to increase resilience at our works or in our network will have multiple benefits cutting across other business functions. This is the case where resilience improvements are undertaken at sites where more than one function occurs (such as abstraction, treatment and transport), and where network connectivity reduces the criticality of a failure at a works. For clarity, measures are included under each business function they benefit.

7.1 <u>Water Resources Activity</u>

7.1.1 Existing Vulnerabilities and Risk Management Mechanisms

Throughout its 150 year history Portsmouth Water has paid attention to ensuring the provision of adequate water resources to meet the need of its customers. During the expansion of the Company during the 1960s and 1970s new resources were developed and inter-connections provided to ensure security of supply.

In 1989 Water Resources Planning became part of Ofwat's Business Plan process and Water Resources Plans were produced in 1994 and 1999. In the 2003 Water Act the production of plans became a statutory requirement and the Draft Water Resources Management Plan was submitted to the Secretary of State in May 2008. Following public consultation and further guidance from Defra, an Updated Draft Water Resources Management Plan was produced in July 2010.

The plan covers a twenty-five year planning period, from 2010 to 2035, and is sub-divided into sections:

- Supply Side
- Demand Side
- Supply/Demand Balance
- Options
- Final Planning Solution

Climate change is included in the forecasts for domestic demand and commercial demand. There is also a specific allowance for climate change reduction in water supply. For the current plan the supply reduction only applies to the River Itchen because the impacts on groundwater are so uncertain.

In addition to specific reductions climate change can also be included in "Headroom". This is an allowance for risk and uncertainty and can be seen as a "Factor of Safety" for water supply. More work, based on the outcomes of UKCP09, is being carried out nationally to improve the methodology for including climate change.

Adaption to climate change will require social change in addition to improvements to Building Regulations and Water Regulations. Government policy on issues such as compulsory metering and tariffs will have a direct impact on demand and therefore on the supply/demand balance. The options available to Portsmouth

Water to address any supply demand imbalance are limited by environmental legislation and by the funding mechanism for the Water Industry.

The customers' views on climate change and risk are also important for water resources planning. The Level of Service (LOS), for aspects such as water use restrictions, are part of the public consultation process. If customers are prepared to accept a higher level of risk then water prices can be kept down.

A risk assessment has been undertaken specifically for this report, to separate out climate change related risks from other risks to the supply/demand balance considered in the Water Resources Management Plan. This has the benefit of allowing water resources related climate risks to be compared and prioritised against other climate risks, such as those relating to water quality or asset performance.

It must be noted however, that for water resources it is a simplification of the approach to consider climate change drivers on the supply/demand balance in isolation from other drivers. Other drivers include, for example, population growth, falling occupancy rates (smaller households, building design standards, changes in commercial water use, and reductions, abstraction to meet environmental legislation requirements.

7.1.1.1 Current Supply Status

The Environment Agency has declared the South East of England to be "Seriously Water Stressed". This designation was developed to support the inclusion of compulsory metering in the last Ofwat Periodic Review of Prices (PRO9).

The designation did not reflect the current supply/demand situation for Portsmouth Water. At average demand Portsmouth Water has a surplus until after 2035. This is after taking account of known climate change impacts and sustainability reductions. At peak demand, typically during the summer months, the Company remains in surplus until 2015. At this time additional measures, such as further leakage control will be required to balance sustainability reductions.

Portsmouth Water obtains all its water, either directly or indirectly, from the chalk aquifer of the South Downs. Unlike some other chalk aquifers in East Anglia this system can recharge rapidly and has a very reliable base flow. Drought impacts are usually only felt in the second year after a dry summer and a dry winter. The form and frequency of droughts may be affected by future climate change.

Portsmouth Water has no significant raw water storage and is unable to manage the impact of droughts on supply. With reservoir storage the Company would be able to retain water for use at a more critical time. Demand restrictions can then be used to influence the overall impact of a drought.

The Habitats Directive Review of Consents resulted in site action plans for the River Itchen, Havant and Bedhampton Springs and the "Sussex" group of groundwater abstractions. Licence variations have been agreed for the Sussex Group and for Havant and Bedhampton. Although not legally required until 2015 these sustainability reductions have been implemented now to help protect the environment. The River Itchen licence variation has been agreed but will not be implemented until 2015. This is because the river is also impacted by Southern Water abstraction and sewerage discharges. Further studies are needed to confirm Southern Water's plans and their impact on Portsmouth Water's deployable output.

Portsmouth Water has over 100 years of spring flow data (1908-2010) and over 70 years of groundwater level data (1933-2010 Idsworth Well). There is no clear evidence of climate change in this data but extreme events occurred in 1922, 1934 and 1974. The frequency of extreme events is taken into account in drought planning and in the calculation of peak week demand. Demand restrictions, such as hosepipe bans, are related to a level of service which has a return period.

Studies into the impact of the Water Framework Directive (WFD) have just started and it is possible that further sustainability reductions will be required. If these impact on peak week abstraction then demand management or supply schemes may need to be brought forward in the WRMP.

In 2004 a "Bulk Supply" was provided to Southern Water from the Eastergate Group of licences. This transfer was used extensively during 2005 and 2006 and careful management was required to ensure that the abstraction licences were not exceeded. A WFD study has now been requested for the Aldingbourne Rife which flows nearby. Uncertainty about future environmental requirements and the impact of climate change on natural systems is a major problem for water resources planning.

7.1.1.2 Current Demand Status

The demand for water can be sub-divided into:

- Household
- Non-Household
- Leakage

Household demand is calculated from population data and per capita consumption estimates. Population forecasts in the South East may be impacted by climate change. If the climate along the South Coast becomes warmer and sunnier then migration for work or retirement may increase. Per capita consumption in warmer climates has historically been higher. There will have to be Government interventions to restrict the demand for personal washing and outdoor use.

The coastal plain around Chichester is already used for large scale horticulture. climate change will make these businesses even more attractive in terms of warmer temperatures and more received sunlight (reduced cloud cover). Agriculture will also change but this could be towards lower water use crops such as vines. These businesses may apply for their own abstraction licences and the amount of water remaining for public water supplies may be reduced. Abstractions may also be unlicensed.

The Government has set an overall aspiration to reduce per capita consumption to 130 l/h/d by 2030. This will require compulsory metering of existing properties and water efficiency initiatives. Climate change will make the target more difficult to achieve and needs to be included in the calculations. New homes only add a small amount of demand each year but the impact is cumulative. The standards adopted for new homes can set an example for improvements that need to be made to existing ones. Portsmouth Water is in favour of tighter Building Regulations and Water Regulations. This means that all new homes and refurbished homes meet the same high standards.

The Government has developed the "Code for Sustainable Homes" which is based on a theoretical calculation of per capita consumption. The Code has not proved easy to implement in practise and it has perverse outcomes in terms of climate change. The highest levels of the Code (5/6) can only be achieved with rainwater harvesting or greywater reuse. These supply options have a higher carbon footprint than mains water[9] and therefore contribute more to climate change.

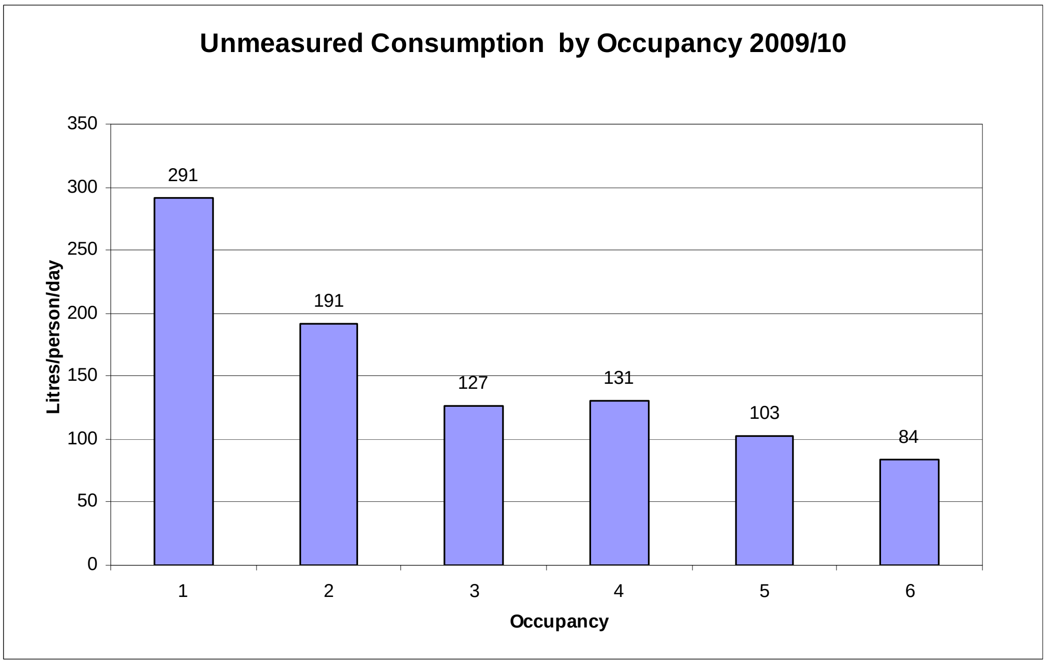
Domestic scale rainwater harvesting also reduces security of supply because water will not be available in a drought and perhaps not available during peak demand in a dry year. After a winter of little or no rain it is unlikely that customers will have saved water for the following summer. The use of rainwater harvesting allows developers to install less efficient white goods and showers under the Code. This further impacts on the carbon footprint and increases running costs for new homes. It is also critical for Portsmouth Water's activities to have a significant increase in demand during hot, dry conditions when systems normally reliant upon rainwater harvesting revert back to mains water supplies.

Portsmouth Water has no significant raw water storage and is unable to manage peak week supplies. This means that peak demand management is more important and initiatives such as metering and water efficiency should be targeted this time of year and this type of demand. In the past this has resulted in sprinkler metering policies and the promotion of water butts for garden us. With Climate change it is likely that personal washing will become more important for peak demand. In hotter drier conditions people will shower and wash their cloths more often. This is reflected in the "micro components" of demand which are used for demand forecasting.

Metering and tariffs have been used in other European countries to suppress peak demands. They have supported investment in more water efficient fixtures and fittings such as aerated showers. Tariffs also encourage changes in behaviour such as shorter showers, limited garden watering and reduced external use. Portsmouth Water has the lowest priced water in the country and this reduces the potential for reductions in consumption due to the price. The Company has been unable to secure funding for compulsory metering and Regulators seem reluctant to allow aggressive tariffs which will impact on demand. Expenditure on metering without suitable peak tariffs will not be cost effective and will have a high carbon footprint.

An additional problem for reducing demand is the reduction in household occupancy with time. This is a social trend related to divorce, lifestyle and an ageing population. Per capita consumption for smaller households is higher because there are few economies of scale. The washing machine and dishwasher are less likely to be full and external use is divided by a smaller number. This is illustrated in the graph below.

[9] Environment Agency Report SC090018



Another influence on per capita demand in the South East is affluence. Compared to the national average per capita consumption in Portsmouth Water area of supply is 14% higher[10]. Climate change is likely to put more pressure on demand with expenditure on items such as pressure washers, garden watering systems and swimming pools.

Climate change will increase the severity of droughts and may make these more frequent. This will have an impact on drought planning with customers having to accept more frequent restrictions on demand or higher bills to pay for additional water resources. This could be a particular problem for Portsmouth Water because customers are used to a very high level of service. There have not been any restrictions since 1976.

Ofwat has now set statutory “Water Efficiency Targets” for all water companies and these have been included in the demand forecasts. The decision not to include climate change in the Business Plan resulted in the removal of compulsory metering from Portsmouth Water’s 2010-2015 expenditure plans. Metering and tariffs are the best way to encourage water efficient products and changes in behaviour.

7.1.1.3 Water Resources Management Planning

Strategic risks to the supply/demand balance are managed through the Statutory Water Resources Management Plan process. The objective is to set out a twenty five year, least cost, plan to ensure that a certain level of service is maintained. If the return period of an event exceeds the level of service then the Drought Plan will be implemented instead.

The Draft Water Resources Management Plan (WRMP) was produced in May 2008 and was based on guidance published by the Environment Agency. Following a period of public consultation an Updated Draft was published in July 2010. Portsmouth Water expect the Updated Plan to be formally approved later this year.

[10] Tynemarch Report PROC/01/0062, August 2007

An Annual Review is then required with the whole planning process repeated after five years.

The majority of stakeholders regard security of supply as a key issue and acknowledge that adaptation to Climate Change is important. For the next round of planning the Water Industry will have access to more “robust” estimates of Climate Change impacts on surface waters and groundwater. The EA will publish new guidelines and it may be necessary to consider an even lower level of service for restrictions of say 1 in 10. This will have impacts on the source yield assessments and the peaking factor used to calculate peak week demands.

Portsmouth Water are a peak driven company and the Regulators have challenged the promotion of winter storage as a solution to this. Storage is a good adaptation to climate change and customers have supported this aspect of the plan in the past.

The Updated Draft WRMP contain the following key elements:

- Leakage Saving Initiative 2016-2020
- Farlington Washwater Recovery 2018
- Compulsory Metering 2016-2030
- Havant Thicket Winter Storage Reservoir 2035

If an acceptable methodology for climate change is approved by the Regulators then some, or all, of these measures will be in the 2014 Plan. If the Plan is based on a lower level of service then the Drought Plan may start to influence expenditure.

7.1.1.4 Drought Planning

The more extreme risks to the supply/demand balance are managed through the statutory Drought Plan process. Guidance was produced by the EA and Portsmouth Water published a Draft Plan which was subject to public consultation. The Final Drought Plan was published with the Secretary of State’s approval in October 2008. Drought Plans are produced on a three yearly cycle and so the next plan will be developed at the end of 2011.

Drought Plans follow on from the WRMP and look at a series of more extreme events. For Portsmouth Water these scenarios were:

- Scenario “A” a dry autumn followed by a dry summer
- Scenario “B” a multi-season drought with a dry year followed by a dry summer
- Scenario “C” two dry summers followed by a dry winter

These scenarios are based on historical drought events and do not allow for future climate change. In future plans it may be possible to use groundwater models to predict the impact of more severe events. In effect Scenarios A, B and C will become more frequent and further more extreme scenarios will need to be considered. Further guidance on drought planning is due to be published by the Environment Agency shortly.

7.1.2 Expected impacts of climate change

A climate change risk assessment was performed, incorporating all supply-side and all demand-side risks.

The risk assessment is presented in the table at the end of this section. Further commentary on the strategic risks to the supply/demand balance is provided below.

7.1.2.1 Sea Level Rise

- *Saline intrusion; borehole sources no longer viable due to rising salinity.*

  Risks were assessed by location. The consequence of this occurring was scored according to source output and the likelihood was scored by applying our asset height data against the sea level rise projections. There is uncertainty, as saline intrusion will depend upon borehole depth and the hydrology of the aquifer. To accommodate this, a precautionary screening was applied that would warrant more detailed assessment if exceeded. One site, Fishbourne, is considered to be at moderate risk of tidal saline inundation in the long term. This was already known to the Company and is a combination of lower hydraulic head in the aquifer compared to other company sources, elevation of the source and proximity to the coast. However, the risk may be addressed with relatively simple engineering solution. All other sites were found to be at low risk, with high certainty in the near to medium term.

  Existing conductivity monitoring by the Company will identify any salinity events.

- *Saline intrusion; springs source no longer viable due to rising salinity.*

  The springs at Havant and Bedhampton are one of our above-ground assets of lowest elevation. However, the risk of saline intrusion of the springs is considered to be very low due to the very high hydraulic head of the system. For example, we believe that there are a number of additional springs associated with the network already located in the estuary and on the harbour floor which do not cause salinity in the rest of the system.

  The Company believes the hydraulic head of the system will prevent saline intrusion. Existing conductivity monitoring by the Company will identify any salinity events.

  Risks are therefore scored as low with high certainty.

- *Estuarine reaches move upstream causing rising salinity at River Itchen Source*

  The risk of rising salinity at the River Itchen source works due to sea level rise is considered to be low until the end of the century, with a high degree of certainty. An initial screening assessment of future seas at 3mAOD was applied to asset height data, to accommodate current sea levels against ordnance datum, sea level rise of 0.9m (high scenario 2080s, 95th percentile), high tide and storm surge. The river intake is situation at a height of 4.58mAOD and therefore does not warrant detailed investigation at this stage.

  Existing conductivity monitoring will identify any salinity events.

- *Asset loss due to coastal change*

  Asset loss from coastal change was also included, based on floor level assessments against sea level rise projections (to a screening level of 3mAOD). A small number of the Bedhampton Springs are near to the tidal zone and may be at risk of inundation during rare tidal and storm surge events towards the end of the Century, however the long-term viability is not considered to be at risk from chronic salinity.

  Fishbourne may be at risk from occasional inundation in the long term.

  The consequence was scored as low due to the small proportion of our distribution network that may be at risk, and the opportunity for a simple engineering solution at Fishbourne when required.

  Risk of complete asset loss from coastal change is considered to be low with a high degree of certainty.

- *Population migration away from areas at risk of coastal change*

  Analysis of the Shoreline Management Plans relevant to our area (North Solent Shoreline Management Plan and South Downs Shoreline Management Plan) shows a policy of 'Hold the Line' in the significant majority of populated urban areas in our area of supply up to Epoch 3 (50-100 years). Therefore we consider the risk of significant population migration affecting the supply-demand balance in our supply zones this Century to be very low. This is further mitigated by the degree of network connectivity the Company has established over recent decades that enables the Company to operate as a single water resources zone.

  Risks are considered to be low with a high degree of certainty.

7.1.2.2 Reduced Summer Rainfall

- *Reduced aquifer recharge during summer months leading to lower groundwater levels and reduced source yield*

  August scenario

  Projections show that we can expect an 8-12% reduction in summer precipitation by the 2030s (central estimates). The critical threshold has been determined from the level of headroom included in our Water Resources Management Plan.

  All of our groundwater sources experience a lag time in the aquifer of approximately three months, meaning that whilst the minimum precipitation occurs in August, the minimum groundwater levels occur in October. This significantly reduces the risk to source yield in August, our 'critical period'. Since our WRMP already models a dry year scenario of our critical period, the risk of current planning for the August supply-demand balance not being sufficient is considered to be low in the near term with a high level of certainty. The medium and long term risks are also considered to be low, with medium certainty as it extends beyond our planning horizon and is dependant upon future water resources management planning guidelines.

October scenario

In a typical year, groundwater levels (and thus source yields) reach their minimum levels in October due to the three month lag time in the aquifer. However, this is not critical for water supply because demand for water has also fallen significantly, compared to the peak experienced in the summer. Reduced summer precipitation caused by climate change may cause groundwater levels in October to fall further than current planning accommodates, which may trigger a new critical period in water resources management planning. The risk of this occurring is considered to be low in the near and medium term. This is because our historical monitoring of groundwater levels show that levels do not fall below 12mAOD even in drought years, due to the non-seasonal base flow in the aquifer. Our existing WRMP incorporates an extreme low scenario of deployable output associated with these groundwater levels (where sources are 'source constrained' as opposed to 'license constrained'). Whilst the UKCP09 data shows significant changes in seasonal rainfall patterns, there is little projected change in the net annual total at the central estimates of all scenarios. Therefore, under the central estimates we consider that the non-seasonal base flow will remain relatively unchanged over the coming Century, and thus, climate change is unlikely to trigger a new critical period in water resources management planning.

Under the more extreme scenarios, such as the tails of the high emissions scenario, we may experience a reduction in total annual rainfall of 12% by the end of the century. This may cause a long-term downward trend in groundwater level minima and thus trigger a new critical period in water resources management planning. The likelihood and thus risk of this occurring was assessed as low, with a medium degree of certainty.

Further aquifer and water resources modelling undertaken in AMP5, by the Company, the Environment Agency and UKWIR will provide further information on risks from reduced summer rainfall.

Future risks will be incorporated into future water resources management planning cycles.

- *Reduced groundwater levels leading to saline intrusion*

Saline intrusion occurs where negative hydraulic head occurs in the aquifer at the tidal limit. This is not expected to occur within the Company's area, as the Company does not propose to increase abstraction and will continue to operate the hands off flow conditions on the water courses entering the coastal wildlife sites. Whilst falling groundwater levels may occur due to reduced recharge, the extent is not expected to be sufficient to cause saline intrusion. Risks are therefore scored as low with a high degree of certainty.

- *Increased abstraction by other (existing) catchment users*

Other catchment users, such as those in agriculture, will experience pressures arising from reduced summer rainfall. Increased abstraction by these users is expected to result which will reduce groundwater levels further and reduce water available for public water supply. Longer term however, there may be a natural transition to less water-intensive crops.

The risk is scored as low in the near term, rising to high in the long term. Certainty is low as the risk depends upon the actions of third parties.

- *Increased risk of breach of environmental flow requirements in water courses, reducing reliability of sources*

  The Company currently operates a Hands Off Flow agreement on the water courses of the Havant and Bedhampton Springs and is in the process of agreeing a similar agreement for the River Itchen. These are essentially minimum flows in the watercourses below which the Company can no longer abstract water to avoid breaching the requirements of the designated environmental sites under the Habitats Regulations.

  Environment Agency figures[11] suggest flows in English rivers could be 10-15% less by 2050s, and chalk streams are especially vulnerable to these effects. With reduced summer rainfall, the risk of reaching these threshold Hands Off Flows increases and therefore the source becomes less reliable for public water supply.

  The Company is undertaking further investigations in AMP 5 under the Habitats Regulations and Water Framework Directive that may result in further license reductions, and the requirement of further Hands Off Flow agreements.

  The risk is considered to be medium in the near term as the Company does not feel this risk is adequately reflected in current headroom, and it may affect a number of our sources during our critical period (peak demand). Medium and long term risks have also been assessed as medium, with falling certainty.

  The planned AMP 5 investigations and modelling work will provide more information, and this risk will be reviewed in the next water resources management planning cycle.

- *Increased peak demand for water from permanent population*

  Projections show a 8-12% reduction in precipitation during the summer months by the 2030s (central estimates), and a 14-16% reduction in August, our critical period. Without intervention we expect this to lead to an increase in demand for water, particularly for external use.

  There near term risk is considered low, as demand has been forecasted for our current 25-year WRMP. However, the Company expects reduced summer precipitation to be a critical driver in future demand in the medium and long term. Therefore the risks have been scored as high, with medium certainty.

- *Increased occurrence of drought*

  Occurrence of drought it likely to increase this Century[12]. Currently, our customers can expect a hosepipe ban notionally once in 20 years, which is equivalent to a 5% risk in any given year. This ‘level of service’ has been set through consultation with our customers.

  The Company is vulnerable to an increased occurrence of drought as it has no multiyear storage, although our current WRMP incorporates construction of a winter storage reservoir by 2034.

[11] Environment Agency Science Summary SC070079/SS1, climate change and river flows in the 2050s.
[12] Adaptation Sub-Committee to the Committee on Climate Change, First Report, September 2010

UKWIR[13] identified the need to explore multi-seasonal drought modelling further as this is not currently captured in the UKCP09 data.

The incidence of drought is managed according to our Drought Plan 2007. As groundwater levels approach the trigger curve, water conservation measures are put in place, beginning with a hosepipe ban. Our next Drought Plan will be produced in 2011 and will be the subject of a formal Public Consultation.

The risk of increased drought is considered to be low in the near term, but rising to very high in the long term, as droughts are expected to become much more frequent by the end of the Century. Undertaking operations during a severe drought according to the Company's Drought Plan will have financial and service implications.

7.1.2.3 Increased Winter Rainfall

- *Population migration out of floodplain disrupting the supply/demand balance*

The South East Hampshire Catchment Flood Management Plan (CFMP) finds climate change, with up to a 20% increase in peak flows, to be significant to future flood risk in the region when combined with other factors such as land use change. Approximately 900 additional properties (from the current level of 2600) will be at risk of a 1 in 100 year event by the end of the Century. The main urban areas in our area of supply fall within the CFMP's 'Policy 5' zone, where there is a compelling case for further flood protection, but further social, environmental and financial appraisal is required. However, the Company provides water supplies to 303,000 domestic properties, therefore the number of properties to experience increased flood risk is not a significant proportion of our population, even towards the end of the Century.

The urban areas within the Arun and Western Streams CFMP are generally within the 'Policy 3' zone, where flood risk is currently managed effectively and not expected to increase. The majority of properties expected to become at risk of flooding are on the north side of the Downs and thus outside of our area of supply.

Whilst population migration out of the floodplain may occur, particularly in the later decades of this Century, we find the risk to the regional supply-demand balance to be low, with a high degree of certainty in the near to medium term, and medium certainty in the long term, although it must be noted that our current supply-demand modelling extends to a limit of 25 years.

- *Increased aquifer recharge during winter (climate change opportunity)*

Aquifer recharge during winter is likely to increase with climate change. Groundwater levels typically peak in March, following the winter rainfall, and fall off throughout the summer before reaching a minimum level in October. Increased winter rainfall in a 'normal year' may lead to more water available during the summer, and during our peak demand period in August. This is an opportunity that occurs due to the particular properties of our chalk aquifer system. However, there is unlikely to be an opportunity following a dry winter.

[13] UKWIR (2009) Report 09/CL/04/11

7.1.2.4 More intense winter rainfall

- *Increased compaction of soil surface leading to reduced aquifer recharge*

  Aquifer recharge will be affected by rainfall intensity. Projections show that on the wettest day of winter, there is likely to be 10% more rainfall by the 2030s, although in summer there is likely to be little net change in the same time horizon.

  Due to the underlying chalk geology which readily soaks up rainfall even under intense rain, the Company expects increased winter rainfall to override this effect and lead to a net increase in winter aquifer recharge. Risks are therefore assessed as low with a high degree of certainty.

- *Population migration away from areas at risk of surface water flooding*

  The South East Hampshire CFMP stated that the underlying chalk geology means that runoff in the upper catchments is not expected to increase significantly from climate change, and is therefore unlikely to affect larger event flood peaks in the wider catchment.

  Surface water flooding was also included in the flood risk assessment in the CFMPs, which found that the proportion of the population that we serve that is likely to experience significantly increased flood risk by the end of the Century is small (discussed above). We therefore conclude that population migration away from areas at risk is likely to be small and presents a low risk to the supply-demand balance in the near, medium and long term, with a high degree of certainty.

7.1.2.5 Reduced cloud cover

- *Increase in agriculture and horticulture leading to increased abstraction by other catchment users*

  Increased temperatures and more sunlight exposure may lead to diversification and increase in agriculture, and result in changes to abstraction by other catchment users. These abstractors may be unlicensed.

  The near term risk is considered to be low, however this rises significantly in the medium and long term to a medium-level risk. Certainty in this assessment is low.

7.1.2.6 Increased summer temperatures

- *Increased evapotranspiration*

  The Company is not vulnerable to evaporation as the Company has no water resources reservoirs. However, as temperatures increase, evapotranspiration in the catchment is likely to increase which will reduce aquifer recharge.

  The effects are likely to be minor when compared to other climate impacts on water resources. Thus the risk is considered to be low.

- *Increased peak demand for water from permanent population*

Hotter summers are likely to lead to a lifestyle change that we expect to impact upon demand for water. Particularly, without intervention we expect an increase in demand for water for external use during our peak period in summer. Globally, hot and developed societies may have per capita consumption in excess of 300 litres per day.

The near term risk is considered low, as demand has been forecasted for our current 25-year WRMP. However, the Company expects rising summer temperatures to be a critical driver in future demand in the medium and long term. Therefore the risks have been scored as high, with medium certainty.

- *Increased demand for water from seasonal (tourist) population*

  Increased temperatures are likely to lead to an increase in summer tourism throughout our area of supply, which will cause an increase in demand for water.

  This has been scored as low in the near term but rising to high in the medium and long term. Certainty in this assessment reduces with time.

- *Increased demand from net inward migration of retirement population*

  The South East of England may become increasingly popular as a retirement destination. Population change and new development are assessed through the Company's planning mechanisms. The retired population may use more water for external use therefore this social change is important for demand for water.

  The risk has been scored as low in the near term, rising to high in the long term, with falling certainty.

- *Increased soil fracturing in summer leads to accelerated aquifer recharge when rains begin (climate change opportunity).*

  It is possible that aquifer recharge may be enhanced by soil fracturing caused by dry summers, although certainty is very low. The Environment Agency owns the regional hydrological model.

Climate Change risks to the supply/demand balance are presented in the table below.

6. Addressing current and future risks due to climate change - summary (one line is requried per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	Likelihood score (near, medium, long term)	Consequence score	Risk score (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
Water Resources	Sea level rise	Saline intrusion of groundwater (borehole sources)	3mAOD (screening assessment)	Low	No assets with flood level below 4.45mAOD. No experience of saline intrusion to date. Fishbourne may be at risk in the long term.	1 1 2	4 4 4	4 4 8	H H M	Not this Century
Water Resources	Sea level rise	Saline intrusion of groundwater (Havant and Bedhampton springs source)	3mAOD (screening assessment)	Negligible	Pumping assets not below 4.17mAOD. High hydraulic head of the aquifer.	1 1 1	2 2 2	2 2 2	H H M	Not this Century
Water Resources	Sea level rise	Estuarine reaches move upstream. Rising salinity at River Itchen intake.	3mAOD (screening assessment)	Negligible	River intake is at 4.58mAOD.	1 1 1	5 5 5	5 5 5	H H H	Not this Century
Water Resources	Sea level rise	Water resources asset loss	3mAOD (screening assessment)	Negligible	Potential inundation risk from rare coastal flooding events at some of the Bedhampton Springs, and at Fishbourne. Fishbourne risk is currently acceptable and can be resolved with an engineering solution if risk rises.	1 1 2	2 2 2	2 2 4	H H H	Not this Century
Water Resources	Sea level rise	Population migration away from areas at risk of coastal change.	6,000 properties (2% of our population) (screening level)	Negligible	Hold the Line' policy prevalent across populated areas of our area of supply this century (Shoreline Management Plans)	1 1 1	2 2 2	2 2 2	H H H	Not this Century
Water Resources	Reduced summer rainfall	Lower groundwater (and/or increased abstraction) leads to saline intrusion		Negligible	Saline intrusion occurs due to negative hydraulic head in the aquifer. At the tidal limit. This is not expected to occur.	1 1 1	4 4 4	4 4 4	H H H	Not this Century
Water Resources	Reduced summer rainfall	Reduced aquifer recharge during summer months leads to reduced source yield in summer	Headroom in WRMP	Negligible	Aquifer has a three month time lag therefore summer source yields are affected by winter and spring rainfall. The WRMP models low deployable output.	1 1 1	5 5 5	5 5 5	H H M	Not this Century
Water Resources	Reduced summer rainfall	Reduced aquifer recharge during summer months leads to reduced source yield in October	Headroom in WRMP	Negligible	Minimum groundwater levels usually occur during October due to the three month time lag in the aquifer. Groundwater minima may fall due to reduced summer rainfall however we do not expect this to cause a new 'critical period' in WRMPing. We expect our critical period to remain as the peak demand week.	1 1 1	3 3 3	3 3 3	H M L	Long term (late Century)
Water Resources	Reduced summer rainfall	Increased abstraction by other catchment users	Headroom in WRMP	High	Other catchment abstractors may be unlicensed. The Company expects abstraction for agriculture and horticulture to increase.	1 3 4	3 3 3	3 9 12	L L L	Medium term (mid-Century)

6. Addressing current and future risks due to climate change - summary (one line is requried per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	Likelihood score (near, medium, long term)	Consequence score	Risk score (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
Water Resources	Reduced summer rainfall	Increased risk of breach of environmental flow requirements in water courses, reducing reliability of sources	Headroom in WRMP	High	Chalk streams especially vulnerable. Environment Agency figures suggest flows could be 10-15% less by 2050s. The Company expects more environmental flow agreements in the future. The Company does not feel this risk as adequately represented in current headroom.	3 3 4	3 3 3	**9** **9** **12**	M L L	Near term (within 20-30 years)
Water Resources	Reduced summer rainfall	Increased demand for water at peak from permanent population	Headroom in WRMP	Very high	Climate is one of many factors affecting demand for water, however drier weather is likely to lead to more demand, particularly for water for external use.	1 3 5	5 5 5	**5** **15** **25**	H M M	Medium term (mid-Century)
Water Resources	Reduced summer rainfall	Increased occurrence of drought	5% chance of drought in a given year, or return period of 1 in 20.	High	Recurrence of drought is likely to increase this century.	1 3 4	5 5 5	**5** **15** **20**	M L L	Medium term (mid-Century)
Water Resources	Increased winter rainfall	Population migration out of floodplain	6,000 properties (2% of our population) (screening level)	Low	Proportion of population to become at risk of flooding due to climate change is relatively small. We therefore do not expect significant migration to occur that could disrupt the regional supply-demand balance.	1 1 2	2 2 2	**2** **2** **4**	H H H	Long term (late Century)
Water Resources	Increased winter rainfall	Increased aquifer recharge during winter (climate change opportunity)	N/A	N/A	Due to three month time lag in the aquifer, more water may be made available during the summer and peak demand period following a 'normal' winter. This will not be the case following a 'dry' winter, however.	N/A N/A N/A	N/A N/A N/A	**N/A** **N/A** **N/A**	N/A N/A N/A	Medium term (mid-Century)
Water Resources	More intense winter rainfall	Increased compaction of soil surface leading to reduce aquifer recharge	Headroom in WRMP	Negligible	The Company expects the increase in winter rainfall to 'override' this effect and lead to a net increase in winter aquifer recharge. Risk is therefore low.	1 1 1	1 1 1	**1** **1** **1**	H H M	Not this Century
Water Resources	Increased winter rainfall	Population migration away from areas at risk of surface water flooding.	6,000 properties (2% of our population) (screening level)	Low	The CFMPs for our area find that, due to the underlying chalk geology, surface water runoff from the upper catchments is not significant to flood risk. Population to become at risk due to climate change is low throughout this century.	1 1 2	2 2 2	**2** **2** **4**	H H H	Long term (late Century)
Water Resources	Reduced cloud cover	Increase in agriculture leading to increased abstraction by other catchment users	Headroom in WRMP	High	Other catchment abstractors are unlicensed. The Company expects abstraction for agriculture and horticulture to increase.	1 3 4	3 3 3	**3** **9** **12**	L L L	Medium term (mid-Century)
Water Resources	Increased summer temperatures	Increased evapotranspiration impacting aquifer recharge	Headroom in WRMP	Low		1 2	2 2	**2** **4**	H M	Long term (late Century)

6. Addressing current and future risks due to climate change - summary (one line is requried per risk)										
Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	**Likelihood score** (near, medium, long term)	**Consequence score**	**Risk score** (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
						2	2	**4**	L	
Water Resources	Increased summer temperatures	Increased demand for water from permanent population, particularly at peak demand	Headroom in WRMP	Very high	Lifestyle change associated with hotter temperatures.	1	5	**5**	H	Medium term (mid-Century)
						3	5	**15**	H	
						5	5	**25**	M	
Water Resources	Increased summer temperatures	Increased demand for water from seasonal (tourist) population, particularly at peak demand	Headroom in WRMP	Very high	Tourism is expected to increase.	1	5	**5**	H	Near term (within 20-30 years)
						3	5	**15**	M	
						5	5	**25**	L	
Water Resources	Increased summer temperatures	Increased soil fracturing in summer leads to accelerated aquifer recharge when rains begin.	Headroom in WRMP	N/A	Very low certainty; one theory of aquifer modelling for the Company's geographical area.	N/A	N/A	N/A	N/A	Medium term (mid-Century)
						N/A	N/A	N/A	N/A	
						N/A	N/A	N/A	N/A	
Water Resources	Increased summer temperatures	Increased demand from net inward migration of retirement population	Headroom in WRMP	Very high	Population increase and new developments are part of normal planning. Increased risk of retirement population associated with external use.	1	3	**3**	H	Medium term (mid-Century)
						3	3	**9**	M	
						5	3	**15**	L	

7.2 Abstraction Activity

Overview

Portsmouth Water has 21 source works across Hampshire and West Sussex.

These are comprised of:

- 1 river source works (River Itchen)
- 1 springs source works (Havant and Bedhampton Springs), and
- 20 borehole source works.

The main assets involved are mechanical and electrical (M&S) assets, principally low lift surface pumps and borehole pumps, and civil engineering structures such as concrete channels and buildings. The typical asset lives of the assets involved ranges from seven years for control equipment to 50+ years for concrete structures and buildings, as outlined in the table below. Asset life duration is important for climate change adaptation planning because it gives an estimate of the frequency with which assets will be replaced. It also indicates the time horizons we need to consider in terms of climate change resilience of that asset, which will be different for long and short life assets.

Asset type	Asset	Asset life (years)
Mechanical and Electrical	Low lift surface pumps	15
Mechanical and Electrical	Borehole pumps	15
Mechanical and Electrical	Control equipment	7
Mechanical and Electrical	Generators	15
Civils (concrete structures and buildings)	Concrete channels	50+
Civils (concrete structures and buildings)	Buildings	50+

The abstraction activity is highly energy intensive; accounting for approximately 75% of our energy use[1].

7.2.1 Existing Vulnerabilities and Risk Management Mechanisms

Existing vulnerabilities are managed proactively by the Company and a number of measures have been undertaken. Those of significance to climate change adaptation are listed below:

- Significant stand-by electricity generation established to ensure interruptions to mains electricity can be accommodated. These generators are tested on a monthly basis.
- Significant distribution network interconnectivity built over recent decades to minimise ‘single source dependence’ for our customers and increase system robustness overall. Appendix 1 shows these strategic links
- Flood Resilience Assessment undertaken in 2009 which led to flood resilience improvements funded for AMP 5 (2010-2015) at four source works

[1] Portsmouth Water Carbon Management Plan, March 2010

- Source outage assessments undertaken and incorporated in to operations and planning

- Drought Plan undertaken periodically, most recently in 2007, to manage the impacts of a drought event according to severity

- Emergency Plan developed and audited annually by Defra, including managing the impacts of a flooding event and severe storm in our area of supply

- Asset performance data collected and used to develop the cost-benefit case of capital maintenance activity to the financial regulator

- The Company has a policy of providing at least two days storage in service reservoirs (Potable Storage business function) which enables shutdowns of 24 hours or more to be accommodated at most source and treatment works without causing an interruption to supplies.

7.2.1.1 Electricity Supply Security

Diesel powered standby electricity generation has been established at 17 source works (borehole source works and the Havant and Bedhampton Springs).

At the River Itchen works an electricity ring main has been established on site which has two distinct feeds from the mains electricity supply which significantly reduces the risk of a supply interruption.

The Company also has a number of mobile (portable) electricity generators.

7.2.1.2 Flooding

A Flood Resilience Assessment of Company assets and sites was undertaken in 2009 which included source works. The assessment utilised both the Environment Agency Flood Zone Mapping and the Company's own experience of flooding events. High risk sites are defined as those within Flood Zone 3, vulnerable to a 1 in 100 year fluvial and/or a 1 in 200 year coastal flooding event. Low risk sites are defined as those within Flood Zone 2, vulnerable to a 1 in 1000 year flooding event. The results of the assessment are summarised below.

Two source works, Aldingbourne and Lavant, were found to be located within Flood Zone 3. Drawing on the Company's experience, a further two source works, Westergate and West Street, were also identified where significant groundwater flooding has been experienced.

The Havant and Bedhampton Springs are a special case because they are distributed across a wide area. The Havant Springs are broadly split in to two groups, those located at our Head Office site and those located throughout Havant town centre (the 'Town Springs'). A number of the springs have been in use for public water supply since 1860. Some of the Town Springs are located within Flood Zone 3 and some of the Head Office springs are within Zone 2. The Town Springs can be readily isolated from the other springs in the network. It is therefore anticipated that in the event of the Town Springs being flooded, these springs would be isolated and allowed to overflow to waste. Whilst such an event would reduce the yield of the springs, it is not expected that it would not compromise customers' supplies since a flood event affecting this site is very unlikely to be coincident with a period of peak demand.

A number of the Bedhampton Springs are located within Flood Zone 2. The Springs were first developed in 1880 and there were known flooding events in the late 19th and early 20th centuries. However, there has been no further flooding of the site since the development of a storm-water drain in the early 1900s and the channelling of the Hermitage Stream in the 1950s.

As a result of this assessment, flood resilience improvements have been proposed and funded in AMP5 at four source works:

- assets at two sites (Aldingbourne and Lavant) found to be at risk of flooding from a 1 in 100 year event (Environment Agency Flood Zone 3)

- assets at a further two sites (Westergate and West Street) which have experienced repeated groundwater flooding

The flood risks to the Havant and Bedhampton Springs can be managed operationally. All other source works sites were found not to be at risk from flooding.

Seven sites were found from the Flood Maps to be at risk of access problems during a flooding event. The Company has a number for four-wheel drive vehicles which would be suitable for dealing with flood waters. No further investment in terms of four-wheel drive vehicles is therefore proposed.

In order to justify the cost of flood resilience improvements a cost benefit analysis was performed. This included an assessment of the number of properties (customers) likely to be affected if an interruption to supply occurred, and the potential compensation payments that the Company would make in this instance according to our service commitment. Implementing modest flood resilience improvements was found to be cost-beneficial when compared to the risk. The scheme has been approved by Ofwat and is currently in the detailed design stage. Measures are likely to include airbrick covers, raising of cable entries, flood covers on doors and stocking of sandbags and will be implemented by 2015.

The Executive Summary from the Flood Resilience Assessment 2009 is included in Appendix 2. And the flood mapping for our area are shown in Appendix 3

The Company has also recently improved its digital mapping system to make better use of third party data, including the Environment Agency's coastal and river flood risk maps and surface water flood risk maps across its operational area. Analysis of this data and the findings from the Flood Resilience Assessment are of use in informing the flood management aspects of our Emergency Plan, which covers emergencies which affect our customers. The Company will also continue to review new flood risk mapping information from the Environment Agency when it becomes available.

7.2.2. Expected impacts of Climate Change

A climate change risk assessment was performed, incorporating all risks to the abstraction activity. This risk assessment is presented in the table at the end of this section. Further commentary on the strategic risks is provided below.

7.2.2.1 Sea level rise

- *Asset loss or outage from coastal change*

  The risk of asset loss from coastal change was assed by applying a screening level assessment of 3mAOD to asset floor data, although loss of assets to coastal change would not preclude abandonment of source due to saline intrusion. No abstraction related assets are considered to be at risk of loss due to coastal change. The Fishbourne source may be at risk of infrequent outage due to tidal saline inundation in the long term. If the risk becomes unacceptable, it can be addressed with a relatively simple engineering solution.

Risk of complete asset loss from coastal change is considered to be low with a high degree of certainty.

7.2.2.2 Increased summer temperatures

- *Reduced operating efficiency of motors*

Mechanical and electrical equipment can be prone to reduced operating efficiency when ambient temperatures rise. The Climate Projections indicate that mean temperatures in August and the hottest day of summer are likely to be 2ºC warmer by the 2030s, and 3-5ºC warmer by the 2080s. However, the risk to abstraction is considered to be low in the near, medium and long term, with a high degree of certainty, as assets are underground and cooled by groundwater which remains at a cool temperature.

In addition, pump assets have a typical asset life of 15 years. Therefore, a feasibility study and options appraisal will routinely be undertaken on a replacement asset with this periodicity.

- *More extreme wetting and drying cycles leading to accelerated asset deterioration*

More extreme wetting and drying cycles may lead to accelerated asset deterioration. The risk is considered to be low in all time horizons as it is unlikely to result in significant additional investment being required and is unlikely to compromise service provision. Certainty is high in the near term and medium in the medium and long term.

The Company collects detailed asset performance data in order to justify capital maintenance activity to Ofwat.

- *Increased occurrence of heat wave events*

Peak summer temperatures are projected to increase over the coming century, and heat wave events will become more common.

The heat wave event in 2006 caused road surfaces to melt in Durham and Cumbria. The Company does not consider that road melt (causing access problems) would significantly impact upon the abstraction function and has scored this risk as low with a high degree of certainty.

7.2.2.3 Increased winter rainfall

- *Increased flood risk from groundwater and rivers*

The Projections show that we can expect rainfall in winter to increase by 10% by the 2030s and 20-32% by the end of Century at the central estimate. Some of our sources are at risk of flooding from groundwater and rivers, as discussed above. With increased winter rainfall, flood risk to our abstraction-related assets is likely to increase. Where flood resilience improvements are being undertaken in AMP 5, flood level assessments have been undertaken based on current risk, and then an additional headroom for climate change has been applied when determining the flood levels to defend against. The Company has been making significant improvements to its use of third party geographical data and will continue to review revised flood risk maps as they become available.

Flood risk from increased winter rainfall is considered to be low in the near term, with a high degree of certainty, as flood resilience improvements are currently being undertaken. These sites will also be resilient to increase flood peaks due to climate change. The risk of climate change causing further sites to be at risk of flooding is considered to be medium in the medium and long term, from a combination of moderate consequence and high likelihood. Certainty in this assessment reduces with time in to the future, and the Company will review flood maps when they become available.

7.2.2.4 More intense winter rainfall

- *Increased risk from pluvial flooding*

Projections show us that there may be up to 10% more precipitation on the wettest day of winter by the 2030s, and 30% more by the 2080s (central estimates). We can also expect more frequent occurrence of extreme events such as intense rainfall leading to floods. The South East Hampshire CFMP found that, due to the underlying chalk geology which readily soaks up rainfall, runoff in open, rural areas is not a main cause of flood risk.

In addition, pluvial flooding events tend to recede faster than groundwater flooding events. Therefore the consequences of a pluvial flooding event are lower as the outage risk is shorter in duration.

The risk of pluvial flooding at our sources works is therefore considered to be low, with high certainty in the near term, but reduced certainty in the longer term.

As a Category 2 responder under the Civil Contingencies Act, the company makes use of the Environment Agency’s existing surface water flood risk maps, and will continue to do so as these maps are updated.

7.2.2.5. Increased storminess

- *Increased interruptions to electricity supply*

Interruptions to electricity supply may become more frequent in the future, due to increased storminess (and increased flooding). The likelihood is difficult for the Company to estimate although the consequences are low due to the existing resilience measures the Company has is place. These include significant standby electricity generation, significant network connectivity that allows outage at works to be accommodated, and an operating policy of maintaining 48 hours of water supplies in service reservoirs.

The Company operates with diesel reserves and has a number of four-wheel drive vehicles, and therefore has provisions to maintain access to site and self-generation of electricity. Consequences for service are therefore minor.

This risk has therefore been scored as low with a high degree of certainty.

- *Increased interruptions to telecommunications and telemetry*

  Interruptions to telecommunications to our source works are rare, as the works generally do not have single line dependence. The Company has back up systems to support critical data monitoring. Risk is therefore assessed as low in the near and medium term, and medium in the long term, with certainty reducing with time.

- *Storm damage to buildings and overhead cabling*

  The risk is considered to be low with high certainty as it would not require significant expenditure to make repairs after a storm event.

7.2.2.6 Reduced Summer Rainfall

- *River intake too high due to reduced river flows*

  The risk of reduced river flows impacting upon our ability to abstract is considered to be very low with a high degree of certainty. This is because the Company is currently in the process of agreeing a Hands Off Flow condition on our river source, the River Itchen, that would mean that the Company would not abstract under low flows anyway, for environmental reasons. This reduction in abstraction is currently included in our WRMP from 2015.

The complete risk assessment undertaken for strategic climate risks to the abstraction activity is shown in the table below.

6. Addressing current and future risks due to climate change - summary (one line is required per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	**Likelihood score** (near, medium, long term)	**Consequence score**	**Risk score** (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
Abstraction	Sea level rise	Abstraction asset loss or outage		Low	Fishbourne may be vulnerable in the long term, but can be resolved with engineering solution.	1	2	**2**		Long term (late Century)
						1	2	**2**		
						2	2	**4**		
Abstraction	Increased summer temperatures	Reduced abstraction pump (M&E) efficiency		Negligible	Motor equipment and pumps utilised in abstraction are sub-surface, and cooled by groundwater.	1	2	**2**		Not this Century
						1	2	**2**		
						1	2	**2**		
Abstraction	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration		Low	Unlikely to lead to significant deterioration of abstraction assets. Asset performance data collected.	1	2	**2**	H	Long term (late Century)
						1	2	**2**	H	
						2	2	**4**	M	
Abstraction	Increased summer temperatures	Increased heat wave events; road melt impedes access to works		Low	Unlikely to significantly impact upon the abstraction activity and cause source works outage	1	1	**1**	H	Long term (late Century)
						1	1	**1**	H	
						2	1	**2**	H	
Abstraction	Increased winter rainfall	Increased flooding to abstraction assets from groundwater and rivers	1 in 100 year risk (Flood Zone 3)	High	The Company has a comprehensive understanding of current flood risks to abstraction assets. We expect winter-spring groundwater levels to rise under climate change which will increase groundwater flooding risk.	1	3	**3**	H	Medium term (mid-Century)
						3	3	**9**	M	
						4	3	**12**	L	
Abstraction	More intense winter rainfall	Increased pluvial flooding to abstraction assets		Low	Due to the underlying chalk geology, surface water runoff is not a significant cause of flood risk in rural areas (CFMP). Events pass quickly.	1	2	**2**	H	Long term (late Century)
						1	2	**2**	H	
						2	2	**4**	M	
Abstraction	Increased storminess	Increased interruptions to electricity supply		Low	The Company has significant standby generation and support systems.	1	1	**1**	H	Long term (late Century)
						1	1	**1**	H	
						2	1	**2**	H	
Abstraction	Increased storminess	Increased interruptions to telecommunications and telemetry		Low	Sites not dependant upon one line. Back-up systems in place.	1	3	**3**	H	Long term (late Century)
						1	3	**3**	H	
						2	3	**6**	H	
Abstraction	Increased storminess	Storm damage to buildings and overhead cabling		Low	Financial costs to make repairs after an event will not be extensive.	1	2	**2**	H	Long term (late Century)
						1	2	**2**	H	
						2	2	**4**	H	

6. Addressing current and future risks due to climate change - summary (one line is required per risk)										
Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	**Likelihood score** (near, medium, long term)	**Consequence score**	**Risk score** (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
Abstraction	Reduced summer rainfall	River intake too high due to reduced river flows		Negligible	Not considered to be material due to forthcoming Hands Off Flow agreement that would cause the Company not to abstract under low flows.	1	2	**2**	H	Long term (late Century)
						1	2	**2**	H	
						1	2	**2**	M	

7.3 Raw Water Quality Activity

Overview

Water quality risks are included throughout this document with the relevant business function in which they occur, in this case at the abstraction stage (source works). This approach is inline with our Drinking Water Safety Plan methodology. The mitigation of the water quality risk may occur at a different stage, such as in the Treatment business function.

Most of the Company's water supplies originate from the chalk of the South Downs and are comprised of 20 borehole source works, one springs source (Havant and Bedhampton) and one river source (River Itchen).

Current Vulnerabilities and Risk Management Mechanisms

Raw water quality risks depend upon the hydrogeology of the catchment and the activities of other catchment users who cause both point-source and diffuse pollution. Raw water quality is also affected by climate, weather and season. For example, low river flows may cause pollutants in a river to become more concentrated, temperature change and sunlight can affect biological growth in the water column, and intense rain can cause high turbidity and other water quality events.

Water quality risks are actively managed through the Drinking Water Safety Plan.

Drinking Water Safety Plan

The Drinking Water Safety Plan (DWSP) is a source-to-tap risk management approach introduced by the Drinking Water Inspectorate (DWI) for the regulation of drinking water quality in 2004. The Plan identifies risks to drinking water quality and the risk mitigation / control measures put in place in order to manage these risks. This approach is central to the way the Company ensures a continuous safe drinking water supply both now and in the future. The Company's DWSP risk scoring methodology has been incorporated in to this climate change risk assessment.

7.3.1 Existing Vulnerabilities and Risk Management Mechanisms

The Company has a number of existing raw water quality risks of relevance to climate change which are actively managed through the Drinking Water Safety Plan.

These include:

- high turbidity and risk of contamination of raw water supplies due to surface runoff from intense rain. This applies mostly to our river source (River Itchen), and our Havant and Bedhampton Springs source due to the presence of swallow holes in the aquifer
- rising nitrates in our raw water across our area of supply
- biological and bacteriological growth in the water column in the River Itchen source.

Portsmouth Water has 20 facilities which have some level of water treatment on site. The Company also operates three nitrate blending mains.

In addition to these assets, the Company also has a catchment management scheme to manage raw water quality risk. The project, known as the Downs and Harbours Clean Water Partnership, is a partnership with the Environment Agency and Natural England set up to work with land operators and other catchment users to promote best practise in land management and nutrient management. The project aims to reduce the upward trend in nitrates in our raw water supplies, which presents a risk to public water supply and the international wildlife sites in the estuaries and harbours.

7.3.2 Impacts of Climate Change

7.3.2.1 Reduced summer rainfall

- *Lower river flows in the River Itchen cause pollutants to become more concentrated*

  Summer precipitation is projected to be 30% less by the 2080s at the central estimate, and 45% less in August (high emissions scenario). Environment Agency figures[2] suggest flows in English rivers could be 10-15% less by 2050s, and chalk streams are especially vulnerable to these effects.

  Lower river flows are likely to cause contaminants and nutrients within the river to become more concentrated, leading to a decline in raw water quality.

  Whilst high nitrates already presents a water quality risk, we consider the probability of a significant increase in the risk due to climate change in the near term to be low.

  In the medium to long term, we expect the risk to be mitigated to an extent by our catchment management programme, however it still presents a issue for raw water quality. The risk has therefore has been scored as medium with a high degree of uncertainty as the level of nutrient pollution within the catchment depends upon the activities of other catchment users.

- *Lower river flows in the River Itchen cause temperatures in the water column to rise*

  Temperatures in the water column are linked to the depth of the water. Higher water temperatures will increase the risk of biological and bacteriological growth in the water column. Biological (typically algal) growth can lead to a trihalomethane risk in the treated water quality and bacterial contamination presents a direct risk.

  The Company does not consider that climate change will significantly increase this risk in the near term, but may do so in the longer term.

  This risk has been scored as low in the near term, rising to medium in the long term. Certainty in this assessment reduces with time.

7.3.2.2 Increased summer temperatures

- *Higher temperatures in the water column (river source)*

[2] Environment Agency Science Summary SC070079/SS1, climate change and river flows in the 2050s.

Higher water temperatures will increase the risk of biological and bacterial growth in the water column. Biological (typically algal) growth can lead to a trihalomethane risk in the treated water quality and bacterial contamination presents a direct risk.

This risk is considered to be low in the near term but medium in the long term. Certainty in this assessment reduces with time.

7.3.2.3 More intense winter rainfall

- *Increased surface runoff leading to increased water quality events*

  Projections show that on the wettest day of winter, there is likely to be 10% more rainfall by the 2030s, although in summer there is likely to be little net change in the same time horizon.

  An increase in intense rain is likely to lead to increased turbidity and a raw quality risk at our river source (River Itchen), and the Havant and Bedhampton Springs due to the presence of swallow holes in the aquifer.

  The consequences are relatively minor as the effects are localised and pass quickly. In addition, the effects of climate change are likely to impact water quality in winter, when demand for water is low and the Company can accommodate more outage of works during high turbidity. The impact on customers is minimised by the Company's high degree of network connectivity and operational policy of maintaining 48 hours of storage in service reservoirs.

  The risk is therefore scored as low.

7.3.2.4 Reduced Cloud Cover

- *Increased biological growth in the water column*

  Cloud cover is expected to decrease by 10-20% by the 2080s at the central estimates. Reduced cloud cover (i.e. increased sunlight) may lead to increased biological growth in the water column, particularly algal growth. This causes a trihalomethane risk in treated water quality.

  The risk is considered low in the near term, rising to medium in the long term. Certainty is this assessment reduces with time.

The complete risk assessment undertaken for climate risks to the abstraction activity is shown in the table below.

6. Addressing current and future risks due to climate change - summary (one line is required per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	Likelihood score (near, medium, long term)	Consequence score	Risk score (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
Raw water quality	Reduced summer rainfall	Contaminants in the River Itchen become more concentrated due to low flows		High		1	3	**3**	H	Medium term (mid-Century)
						2	3	**6**	L	
						4	3	**12**	L	
Raw water quality	Reduced summer rainfall	Low flows cause water column temperature to rise. Increased biological and bacterial growth.		Medium	Risk is likely to increase with time and may be highest in summer, at peak demand.	2	2	**4**	H	Near term (within 20-30 years)
						3	2	**6**	M	
						3	2	**6**	L	
Raw water quality	Increased summer temperatures	Higher temperatures in the water column. Increased biological and bacterial growth.		High	Risk is likely to increase with time and may be highest in summer, at peak demand.	2	2	**4**	H	Near term (within 20-30 years)
						3	2	**6**	M	
						4	2	**8**	M	
Raw water quality	More intense winter rainfall	Increased turbidity events from surface runoff into river source and swallow holes (Havant and Bedhampton Springs)		Low	Risk is likely to be highest in winter, when demand is low, so easier to accommodate.	1	2	**2**	H	Medium term (mid-Century)
						2	2	**4**	H	
						2	2	**4**	M	
Raw water quality	Reduced cloud cover	Increased biological growth in the water column.		Very high		2	2	**4**	H	Near term (within 20-30 years)
						4	2	**8**	M	
						5	2	**10**	L	

7.4 Raw Transportation

Overview

Portsmouth Water has both civil engineering ("civils") assets and mechanical and electrical assets associated with raw water transportation.

These are comprised of:

- 1 raw water trunk main from Havant and Bedhampton to Farlington Water Treatment Works
  - Three raw water mains for transporting water for nitrate blending
- 2 pumping / booster stations (Havant and Bedhampton) and associated control equipment
- Standby generators (diesel) at both booster stations

The typical asset lives associated with these assets are outlined in the table below.

Asset type	Asset	Asset life (years)
Mechanical and Electrical	Booster pump	15
Mechanical and Electrical	Control equipment	7
Mechanical and Electrical	Generators	15
Civils (concrete structures and buildings)	Concrete channels	50+
Civils (water mains)	Water mains	50+

7.4.1 Existing Vulnerabilities and Risk Management Mechanisms

7.4.1.1 Flooding

A Flood Resilience Assessment of Company assets and sites was undertaken in 2009 which included booster stations for raw transportation. The assessment utilised both the Environment Agency Flood Zone Mapping and the Company's own experience of flooding events. High risk sites are defined as those within Flood Zone 3, vulnerable to a 1 in 100 year fluvial and/or a 1 in 200 year coastal flooding event. Low risk sites are defined as those within Flood Zone 2, vulnerable to a 1 in 1000 year flooding event. The assessment showed that Havant Pumping Station is not in an area at risk of flooding. Bedhampton Pumping Station has two boosters on site. One of the two is in the low risk area but the other is not at risk. No resilience improvements are proposed for the site because the risk is within an acceptable level and the Company did not believe that our customers would be willing to fund measures for such a remote event.

Access to Bedhampton Pumping Station may become impaired during flooding events however the Company has sufficient four-wheel drive vehicles to accommodate this risk and does not propose further investment.

The Executive Summary from the Flood Resilience Assessment 2009 is included in Appendix 2 and the flood mapping for the Company's area are included in Appendix 3 (1 is restricted).

The Company has also recently improved its digital mapping system to make better use of third party data, including the Environment Agency's coastal and river flood risk maps and surface water flood risk maps across its operational area. Analysis of this data and the findings from the Flood Resilience Assessment are of use in informing the flood management aspects of our Emergency Plan, which covers emergencies which affect our customers. The Company will also continue to review new flood risk mapping information from the Environment Agency when it becomes available.

7.4.1.2 Standby Electricity Generation

The Company has standby electricity generation facilities at Havant and Bedhampton pumping stations.

7.4.2 Expected Impacts of Climate Change

7.4.2.1 Sea level rise

- *Asset loss or outage from coastal change*
  The risk of asset loss or outage from coastal change was assed by applying a screening level assessment of 3mAOD to asset floor data of above ground assets. Neither of our raw water pumping stations is considered to be at risk from coastal change.

- *Saline intrusion of raw water mains causing increased water quality risk*

  Saline intrusion could lead to a water quality risk.

  The Company's four raw water mains were assessed for risk from saline intrusion. This was assessed from the floor level of the source works combined with main depth data and destination.

  - The Northbrook main transfers raw water from a source at 42.14mAOD to a service reservoir at 80.56mAOD at distance from the coast. Not at risk of saline intrusion.
  - The Maindell main transfers raw water from a source at 12.21mAOD near the coast to a service reservoir at 80.56mAOD. Not at risk of saline intrusion due to asset elevation.
  - The Aldingbourne main transfers raw water from a source at 12.21mAOD to a service reservoir at 80.56mAOD at distance from the coast. Not at risk of saline intrusion.
  - The Farlington mains transfer raw water from the Havant and Bedhampton pumping stations to a water treatment works at 44.64mAOD. Bedhampton station is near the tidal zone and has a floor level of 4.17m. However, due to the high hydraulic head in the aquifer at this location (springs system), saline intrusion of the aquifer and thus water main is considered to be a very low risk.

Risks were assessed as low with a high degree of certainty.

7.4.2.2 Increased summer temperatures

- *Reduced operating efficiency of pumps (M&E)*

  Mechanical and electrical equipment can be prone to reduced operating efficiency when ambient temperatures rise. The Climate Projections indicate that mean temperatures in August and the hottest day of summer are likely to be 2ºC warmer by the 2030s, and 3-5ºC warmer by the 2080s, at the central estimates. The 90th percentile Projections are significantly higher than this.

Pump efficiency may be at risk from higher temperatures in the long term. There is uncertainty in the likelihood of this assessment but the consequences are considered to be low. Booster pumps have a typical asset life of approximately 15 years and it would be prudent to consider temperature rise risks when undertaking a feasibility study on a replacement asset.

Risks have been scored as low with a low degree of certainty.

- *More extreme wetting and drying cycles leading to accelerated asset deterioration (above ground assets)*

  More extreme wetting and drying cycles may lead to accelerated asset deterioration. The risk is considered to be low in all time horizons as it is unlikely to result in significant additional investment being required and is unlikely to compromise service provision. Certainty is high.

  The Company collects detailed asset performance data in order to justify capital maintenance activity to Ofwat.

- *More extreme wetting and drying cycles leading to accelerated asset deterioration (below ground assets)*

  More extreme wetting and drying cycles may lead to accelerated asset deterioration. The risk is considered to be low due to the structural integrity of these assets.

  The Company collects detailed asset performance data in order to justify capital maintenance activity to Ofwat.

- *Increased occurrence of heatwave events*

  Peak summer temperatures are projected to increase over the coming century, and heat wave events will become more common.

  The heatwave event in 2006 caused road surfaces to melt in Durham and Cumbria. The Company does not consider that road melt (causing access problems) would impact upon the raw transportation function and has scored this risk as low with a high degree of certainty.

7.4.2.3 Increased winter rainfall

- *Increased flood risk from groundwater and rivers*

  The Projections show that we can expect rainfall in winter to increase by 10% by the 2030s and 20-32% by the end of Century at the central estimate. Havant pumping station is currently not at risk of flooding (i.e., it is not within Flood Zone 2 or higher). Bedhampton is partially at risk of a 1 in 1000 year event, as discussed above. With increased winter rainfall, flood risk may increase. The Company will continue to monitor this risk and review new risk mapping when it becomes available.

  Flood risk from increased winter rainfall is considered to be low in the near term, with a high degree of certainty. Medium and long term risks have been scored as medium as we expect flood risk to increase with climate change.

7.4.2.4 More intense winter rainfall

- *Increased risk from pluvial flooding*

Projections show us that there may be up to 10% more precipitation on the wettest day of winter by the 2030s, and 30% more by the 2080s (central estimates). We can also expect more frequent occurrence of extreme events such as intense rainfall leading to floods. The South East Hampshire CFMP found that, due to the underlying chalk geology which readily soaks up rainfall, runoff in open, rural areas is not a main cause of flood risk.

In addition, pluvial flooding events tend to recede faster than groundwater flooding events. Therefore the consequences of a pluvial flooding event are lower as the outage risk is shorter in duration.

The risk of pluvial flooding at our pumping stations is therefore considered to be low, with high certainty in the near term, but reduced certainty in the longer term.

As a Category 2 responder under the Civil Contingencies Act, the company makes use of the Environment Agency's existing surface water flood risk maps, and will continue to do so as these maps are updated.

7.4.2.5 Increased storminess

- *Increased interruptions to electricity supply*

The Company has standby generation capabilities at both pumping stations and has vehicles to access site during flooding.

This risk has therefore been scored as low with a high degree of confidence.

- *Increased interruptions to telecommunications and telemetry*

The risk was assessed as being low in the near, medium and long term. This is because the sites are not significantly dependent upon overland telecoms lines. Certainty is high.

- *Storm damage to buildings and overhead cabling*

The risk is considered to be low with high certainty as it would not require significant expenditure to make repairs after a storm event.

The complete risk assessment undertaken for strategic climate risks to the abstraction activity is shown in the table below.

6. Addressing current and future risks due to climate change - summary (one line is required per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	Likelihood score (near, medium, long term)	Consequence score	Risk score (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
Raw water transport	Sea level rise	Asset loss or outage (above ground assets)	3mAOD (screening assessment(	Negligible	Assets are at high elevation	1 1 1	4 4 4	4 4 4	H H H	Not this Century
Raw water transport	Sea level rise	Saline intrusion of mains leading to water quality risk		Negligible	Assets are at high elevation and/or in high hydraulic head aquifer	1 1 1	4 4 4	4 4 4	H H H	Not this Century
Raw water transport	Increased summer temperatures	Reduced raw water transport pump (M&E) efficiency		Low	Consequences are low under feasible temperature rises. Asset life is short.	1 1 2	2 2 2	2 2 4	M L L	Long term (late Century)
Raw water transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration (above ground assets)		Negligible	Very unlikely to lead to significant deterioration of pumping assets. Asset performance data collected. Consequence are low, only slightly shortened asset life.	1 1 1	2 2 2	2 2 2	H H H	Not this Century
Raw water transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration (below ground assets)		Negligible		1 1 1	3 3 3	3 3 3	H M M	Not this Century
Raw water transport	Increased summer temperatures	Increased heat wave events; road melt impedes access to pumping stations		Low	Very unlikely to impact upon raw transportation activities.	1 1 2	1 1 1	1 1 2	H H M	Long term (late Century)
Raw water transport	Increased winter rainfall	Increased flooding from groundwater and rivers	1 in 100 year risk (Flood Zone 3)	Medium	Flood risk assessment was performed in 2009. Partial asset risk from 1 in 1000 year event. Likely to increase with increase winter rainfall.	1 2 3	3 3 3	3 6 9	H M M	Medium term (mid-Century)
Raw water transport	More intense winter rainfall	Increased pluvial flooding		Low	Due to the underlying chalk geology, surface water runoff is not a significant cause of flood risk in rural areas (CFMP). Events pass quickly.	1 1 2	2 2 2	2 2 4	H H M	Long term (late Century)
Raw water transport	Increased storminess	Increased interruptions to electricity supply		Negligible	Standby generation.	1 1 1	1 1 1	1 1 1	H H H	Not this Century
Raw water transport	Increased storminess	Increased interruptions to telecommunications and telemetry		Low	Not dependent upon overland telecommunications lines. Not remote site location.	1 1 2	2 2 2	2 2 4	H H H	Long term (late Century)
Raw water transport	Increased storminess	Storm damage to buildings and overhead cabling		Negligible	Only minor buildings associated.	1 1 1	1 1 1	1 1 1	H H H	Not this Century

7.5 Raw Storage

Overview

Objective: storage of raw (untreated) water

Portsmouth Water has only one asset utilised for raw water storage. This is Highwood Reservoir, an open-air concrete structure situated on site at our River Itchen source and water treatment works. Water is sourced from the river and pumped to the reservoir from which it gravity-feeds in to the treatment works. First stage clarification occurs in the reservoir through the settlement of particulate matter in the raw water.

The asset is a civil engineering asset (concrete structure) as thus has an asset life from new of 50+ years.

7.5.1 Existing Vulnerabilities and Risk Management Mechanisms

7.5.1.1 Flooding

The asset is sited on a hill-top and is therefore not considered to be at risk of flooding, confirmed in the Company's 2009 Flood Resilience Assessment conducted for PR09.

7.5.1.2 Water Quality

The Company has observed high levels of organic growth within the reservoir, particularly of algae during the summer months. Organic matter when combined with chlorine in the treatment process can cause a trihalomethane (THM) risk in the treated water quality. As a result the construction of a roof for the reservoir has been funded in AMP 5 (2010-2015). The Company is currently in the design stage of the roof construction project.

Water quality risks occurring at the raw storage stage are managed through the Drinking Water Safety Plan.

7.5.2 Expected impacts of Climate Change

Without the construction of the roof over Highwood Reservoir climate change would cause increased water quality risks. For example, low river flows may lead to higher concentrations of nutrients from catchment runoff in the river, due to reduced dilution effect. These higher nutrient concentrations combined with increased temperatures and reduced cloud cover (increased sunlight exposure) would have been likely to exacerbate the algal growth issue already occurring in the reservoir. Higher nutrient concentrations may remain a risk for the Treatment business function, however, the algal growth issue in the reservoir will be significantly reduced with the construction of a roof.

The risk assessment identified other potential risks from climate change. These are:

7.5.2.1 Sea Level Rise

- *Asset loss or outage from coastal change*

High wood reservoir is not at risk of coastal change.

7.5.2.2 Increased summer temperatures

- *More extreme wetting and drying cycles leading to accelerated asset deterioration*

  More extreme wetting and drying cycles may lead to accelerated asset deterioration. The risk is considered to be low in all time horizons as it is unlikely to result in significant additional investment being required and is unlikely to compromise service provision. Certainty is high.

  The Company collects detailed asset performance data in order to justify capital maintenance activity to Ofwat.

7.5.2.3 Increased Winter Rainfall

- *Increased flood risk from groundwater and rivers*

  The asset is sited on a hill-top and is therefore not considered to be at risk of flooding even under climate change. Certainty is high.

7.5.2.4 More Intense Winter Rainfall

- *Increased risk from pluvial flooding*

  The asset is sited on a hill-top and is therefore not considered to be at risk of flooding even under climate change. Certainty is high.

7.5.2.5 Increased storminess

- *Storm damage to asset*

  The risk is considered to be low with high certainty as the reservoir is not vulnerable to storm damage.

The table below shows the strategic climate change risks to the raw storage business function.

6. Addressing current and future risks due to climate change - summary (one line is required per risk)										
Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	**Likelihood score** (near, medium, long term)	**Consequence score**	**Risk score** (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
Raw storage	Sea level rise	Asset loss or outage from coastal change	3mAOD (screening assessment)	Negligible	High elevation asset.	1	1	**1**	H	Not this Century
						1	1	**1**	H	
						1	1	**1**	H	
Raw storage	Increased summer temperatures	Accelerated asset deterioration		Negligible		1	1	**1**	H	Not this Century
						1	1	**1**	H	
						1	1	**1**	H	
Raw storage	Increased winter rainfall	Increased flooding from groundwater and rivers	1 in 100 year risk (Flood Zone 3)	Negligible		1	3	**3**	H	Not this Century
						1	3	**3**	H	
						1	3	**3**	H	
Raw storage	More intense winter rainfall	Increased pluvial flooding		Negligible		1	2	**2**	H	Not this Century
						1	2	**2**	H	
						1	2	**2**	H	
Raw storage	Increased storminess	Storm damage to asset		Negligible		1	2	**2**	H	Not this Century
						1	2	**2**	H	
						1	2	**2**	M	

7.6 Treatment

Overview

Portsmouth Water has 19 facilities which have some level of water treatment on site. Sixteen of these have only disinfection (with chlorine gas). Five sites have more complex treatment processes such as rapid gravity filtration, membrane filtration and clarification.

Asset type	Asset	Asset life (years)
Mechanical and Electrical	Chlorinators	2
Mechanical and Electrical	Membranes	7
Mechanical and Electrical	Control equipment	7
Mechanical and Electrical	Generators	15
Civils (concrete structures and buildings)	Clarifiers	50+
Civils (concrete structures and buildings)	Rapid gravity filtration	50+
Civils (concrete structures and buildings)	Buildings	50+
Mechanical and electrical	Pumps	15

Approximately 16% of our energy consumption is used in water treatment.

7.6.1 Existing Vulnerabilities and Risk Management Mechanisms

Existing vulnerabilities are managed proactively by the Company and a number of measures have been undertaken. Those of significance to climate resilience are listed below:

- Significant stand-by electricity generation established to ensure interruptions to mains electricity can be accommodated. These generators are tested on a monthly basis.

- Significant distribution network interconnectivity built over recent decades to accommodate works outage and increase system robustness overall. Appendix 1 shows these strategic links

- Flood Resilience Assessment undertaken in 2009 which led to flood resilience improvements funded for AMP 5 (2010-2015) at four works

- Source outage assessments undertaken and incorporated in to operations and planning

- Asset performance data collected and used to develop the cost-benefit case of capital maintenance activity to the financial regulator, Ofwat, on a five-yearly basis

- The Company has a policy of providing at least two days storage in service reservoirs (Potable Storage business function) which enables shutdowns of 24 hours or more to be accommodated at most source and treatment works without causing an interruption to supplies.

  - Emergency Plan developed and reviewed annually by Defra

- Water quality risks actively managed through the Drinking Water Safety Plan, signed off by the Drinking Water Inspectorate (DWI)

- Construction of a roof over the Itchen works rapid gravity filters planned during AMP 5, to combat algal growth.

Further information is provided below.

7.6.1.1 Electricity Supply Security

Diesel powered standby electricity generation has been established at 17 treatment works.

At the River Itchen works an electricity ring main has been established on site which has two distinct feeds from the mains electricity supply which significantly reduces the risk of a supply interruption.

The Company also has a number of mobile (portable) electricity generators.

7.6.1.2 Flooding

A Flood Resilience Assessment of Company assets and sites was undertaken in 2009 which included treatment works. The assessment utilised both the Environment Agency Flood Zone Mapping and the Company's own experience of flooding events. High risk sites are defined as those within Flood Zone 3, vulnerable to a 1 in 100 year fluvial and/or a 1 in 200 year coastal flooding event. Low risk sites are defined as those within Flood Zone 2, vulnerable to a 1 in 1000 year flooding event. The results of the assessment showed that two works, Aldingbourne and Lavant, were found to be located within Flood Zone 3. Drawing on the Company's experience, a further two works, Westergate and West Street, were also identified where significant groundwater flooding has been experienced. All four of these sites have only chlorination treatment activities.

As a result of this assessment, flood resilience improvements have been proposed and funded in AMP 5 at the four works:

In order to justify the cost of flood resilience improvements a cost benefit analysis was performed. This included an assessment of the number of properties (customers) likely to be affected if an interruption to supply occurred, and the potential compensation payments that the Company would make in this instance according to our service commitment. Implementing modest flood resilience improvements was found to be cost-beneficial when compared to the risk. The scheme has been approved by Ofwat and is currently in the detailed design stage. Measures are likely to include airbrick covers, raising of cable entries, flood covers on doors and stocking of sandbags and will be implemented by 2015.

Access to seven works may become impaired during flooding events however the Company has sufficient four-wheel drive vehicles to accommodate this risk as does not propose further investment.

The Executive Summary from the Flood Resilience Assessment 2009 is included in Appendix 2 and the Flood Mapping is included in Appendix 3.

The Company has also recently improved its digital mapping system to make better use of third party data, including the Environment Agency's coastal and river flood risk maps and surface water flood risk maps across its operational area. Analysis of this data and the findings from the Flood Resilience Assessment are of use in informing the flood management aspects of our Emergency Plan, which covers emergencies which affect our customers. The Company will also continue to review new flood risk mapping information from the Environment Agency when it becomes available.

7.6.1.3 Algal Growth

The Company has experienced algal growth in the rapid gravity filters at the River Itchen treatment works. Algal growth can lead to a trihalomethane risk in the treated water quality.

As a result, construction of a roof over the filters was included in the Company's 2009 Business Plan and approved by Ofwat for AMP 5. The roof project is currently in the detailed design stage.

7.6.2 Expected Impacts of Climate Change

The complete climate change risk assessment for the treatment function is presented in the table at the end of this section. Further commentary on the assessment is provided below.

7.6.2.1 Sea Level Rise

- *Asset loss or outage arising from coastal change*

  A screening assessment of risks from coastal change was applied using a very precautionary level of future seas of 3mAOD, to accommodate current sea levels in Southeast England against Ordnance Datum, future sea level rise of 0.9m (High scenario 2080s, 95th percentile), high tide and storm surge. However, our lowest asset with treatment facilities is at a height of 4.17mAOD and therefore risk of asset loss arising from coastal inundation is considered to be very low and thus no further detailed assessments of risks from sea level rise are required at this time.

7.6.2.2 Increased Summer Temperatures

- *Reduced operating efficiency of pumps (M&E)*

  Mechanical and electrical equipment can be prone to reduced operating efficiency when ambient temperatures rise. The Climate Projections indicate that mean temperatures in August and the hottest day of summer are likely to be 2ºC warmer by the 2030s, and 3-5ºC warmer by the 2080s. Motors used in treatment are relatively small and as a result the costs incurred from reduced motor efficiency would be less. The asset life of a pump is also relatively short.

  The risk has therefore been scored as low in the near term rising to medium in the long term. Certainty in the likelihood assessment is low.

  The risk has been scored as low in the near term rising to medium in the long term.

- *Bacterial growth in rapid gravity filters*

  Bacterial growth in the rapid gravity filters may cause deteriorating water quality in the treatment process. The planned construction of a roof over the filters in AMP 5 will reduce temperatures in the filters and reduce the risk to an acceptable level.

  Risks are therefore scored as low with high certainty.

- *More extreme wetting and drying cycles leading to accelerated asset deterioration*

  More extreme wetting and drying cycles may lead to accelerated asset deterioration. The risk is considered to be low as it is unlikely to result in significant additional investment being required and is unlikely to compromise service provision. Certainty is high in the near term and medium in the medium and long term.

  The Company collects detailed asset performance data in order to justify capital maintenance activity to Ofwat.

- *Increased occurrence of heat wave events impeding works access*

  Peak summer temperatures are projected to increase over the coming Century, and heat wave events will become more common.

  The heat wave event in 2006 caused road surfaces to melt in Durham and Cumbria, causing access problems. Impeded access to treatment works could present a risk to the treatment process.

  Current risks are considered to be low, but rise to medium in the long term.

- *Increased occurrence of heat wave events disruption chemicals supply chains*

  The treatment process is supported by a supply chain for chemicals and dosing agents. Supply chain risks to the treatment process are actively managed through the Drinking Water Safety Plan and as a consequence, stores of the required chemicals and agents are maintained by the Company.

  The risk of supply chain disruption may increase in the future as future heat wave risk increases. Therefore, whilst the current risk is low due to existing risk management mechanisms, the long term risk has been scored as medium.

7.6.2.3 Increased Winter Rainfall

- *Increased flood risk from groundwater and rivers*

  The Projections show that we can expect rainfall in winter to increase by 10% by the 2030s and 20-32% by the end of Century at the central estimate. Some of our treatment facilities are at risk of flooding from groundwater and rivers, as discussed above. With increased winter rainfall, flood risk to our treatment-related assets is likely to increase. Where flood resilience improvements are being undertaken in AMP 5, flood level assessments have been undertaken based on current risk, and then an additional headroom for climate change has been applied when determining the flood levels to defend against. The Company has been making significant improvements to its use of third party geographical data and will continue to review revised flood risk maps as they become available.

  Flood risk from increased winter rainfall is considered to be low in the near term, with a high degree of certainty, as flood resilience improvements are currently being undertaken. These sites will also be resilient to increase flood peaks due to climate change. The risk of climate change causing further sites to be at risk of flooding is considered to be medium in the medium and long term, from a combination of moderate consequence and high likelihood. Certainty in this assessment reduces with time in to the future, and the Company will review flood maps when they become available.

- *Supply chain disruption from regional flooding*

The treatment process is supported by a supply chain for chemicals and dosing agents. Supply chain risks to the treatment process are actively managed through the Drinking Water Safety Plan and as a consequence, stores of the required chemicals and agents are maintained by the Company.

The risk of supply chain disruption is likely to increase in the future as future flood risk increases. Therefore, whilst the current risk is low due to existing risk management mechanisms, the future risk has been scored as medium.

7.6.2.4 More Intense Winter Rainfall

- *Increased risk from pluvial flooding*

Projections show us that there may be up to 10% more precipitation on the wettest day of winter by the 2030s, and 30% more by the 2080s (central estimates). We can also expect more frequent occurrence of extreme events such as intense rainfall leading to floods. The South East Hampshire CFMP found that, due to the underlying chalk geology which readily soaks up rainfall, runoff in open, rural areas is not a main cause of flood risk.

In addition, pluvial flooding events tend to recede faster than groundwater flooding events. Therefore the consequences of a pluvial flooding event are lower as the outage risk is shorter in duration.

The risk of pluvial flooding at our treatment works is therefore considered to be low, with high certainty in the near term, but reduced certainty in the longer term.

As a Category 2 responder under the Civil Contingencies Act, the company makes use of the Environment Agency’s existing surface water flood risk maps, and will continue to do so as these maps are updated.

7.6.2.5 Increased Storminess

- *Increased interruptions to electricity supply*

Interruptions to electricity supply may become more frequent in the future, due to increased storminess (and increased flooding). The likelihood is difficult for the Company to estimate although the consequences are low due to the existing resilience measures the Company has is place. These include significant standby electricity generation, significant network connectivity that allows outage at works to be accommodated, and an operating policy of maintaining 48 hours of water supplies in service reservoirs.

The Company operates with diesel reserves and has a number of four-wheel drive vehicles, and therefore has provisions to maintain access to site and self-generation of electricity. Consequences for service are therefore minor.

This risk has therefore been scored as low with a high degree of confidence.

- *Increased interruptions to telecommunications and telemetry*

  Interruptions to telecommunications to our treatment works are rare, as the works generally do not have signle line dependence. The Company has back-up systems in place to support critical data monitoring. Risk is therefore assessed as low in the near and medium term, and medium in the long term, with certainty reducing with time.

- *Disturbance of flocculant blanket in clarification process*

  The consequences of flocculant blanket disturbance are low and short in duration. The risk is currently acceptable and not expected to be exceeded this Century.

- *Storm damage to buildings and overhead cabling*

  The risk is considered to be low with high certainty as it would not require significant expenditure to make repairs after a storm event.

7.6.2.6 Reduced Cloud Cover

- *Algal growth in rapid gravity filters (River Itchen works)*

  Algal growth causes a trihalomethane risk in treated water quality. This risk will be mitigated by the AMP 5 roof construction project. The risk going forward is therefore considered to be very low with a high degree of certainty.

- *Algal growth in clarifiers*

  The risk is considered low with a high degree of certainty due to the ongoing risk management and planned roof construction project.

Strategic climate risks to the abstraction activity are shown in the table below.

6. Addressing current and future risks due to climate change - summary (one line is required per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	**Likelihood score** (near, medium, long term)	**Consequence score**	**Risk score** (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
Treatment	Sea level rise	Treatment asset loss or outage	3mAOD (screening assessment)	Negligible	Assets at high elevation.	1 1 1	1 1 1	1 1 1	H H H	Not this Century
Treatment	Increased summer temperatures	Reduced treatment pump (M&E) efficiency		Medium		1 2 3	1 1 1	1 2 3	H M M	Medium term (mid-Century)
Treatment	Increased summer temperatures	increased bacterial growth in rapid gravity filters		Negligible	Roof construction approved for AMP 5.	1 1 1	3 3 3	3 3 3	H H H	Not this Century
Treatment	Increased summer temperatures	Increased occurrence of heat wave (road melt) events impeding treatment works access		Medium		1 2 3	2 2 2	2 4 6	H M M	Medium term (mid-Century)
Treatment	Increased summer temperatures	Increased occurrence of heat wave events disrupting chemicals supply chains		Medium	Existing risk management	1 2 3	2 2 2	2 4 6	H M M	Medium term (mid-Century)
Treatment	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated treatment asset deterioration		Negligible		1 1 1	2 2 2	2 2 2	H H H	Not this Century
Treatment	Increased winter rainfall	Increased flooding from groundwater and rivers	1 in 100 year risk (Flood Zone 3)	High	The Company has a comprehensive understanding of current flood risks to abstraction assets. We expect winter-spring groundwater levels to rise under climate change which will increase groundwater flooding risk.	1 3 4	3 3 3	3 9 12	H M L	Medium term (mid-Century)
Treatment	Increased winter rainfall	Regional flooding leading to chemicals supply chain disruption		High	Existing risk management	1 2 3	2 2 2	2 4 6	H M M	Medium term (mid-Century)
Treatment	More intense winter rainfall	Increased pluvial flooding		Low	Due to the underlying chalk geology, surface water runoff is not a significant cause of flood risk in rural areas (CFMP). Events pass quickly.	1 1 2	2 2 2	2 2 4	H H M	Long term (late Century)
Treatment	Increased storminess	Increased interruptions to electricity supply		Low	The Company has significant standby generation and support systems.	1 1 2	1 1 1	1 1 2	H H H	Long term (late Century)
Treatment	Increased storminess	Increased interruptions to telecommunications and telemetry		Low	Sites not dependant upon one line. Back-up systems in place.	1 1 2	3 3 3	3 3 6	H H H	Long term (late Century)
Treatment	Increased storminess	Disturbance of the flocculant blanket		Low	Consequences are low, acceptable level of risk not expected to be exceeded.	1 1 2	1 1 1	1 1 2	H H H	Long term (late Century)

6. Addressing current and future risks due to climate change - summary (one line is required per risk)										
Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	**Likelihood score** (near, medium, long term)	**Consequence score**	**Risk score** (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
Treatment	Increased storminess	Storm damage to buildings and overhead cabling		Low	Financial costs to make repairs after an event will not be extensive.	1	2	**2**	H	Long term (late Century)
						1	2	**2**	H	
						2	2	**4**	H	
Treatment	Reduced cloud cover	Algal growth in rapid gravity filters		Negligible	Risk has been scored with the planned roof in place.	1	1	**1**	H	Not this Century
						1	1	**1**	H	
						1	1	**1**	H	
Treatment	Reduced cloud cover	Algal growth in clarifiers		Negligible	Roof construction in AMP 5.	1	1	**1**	H	Not this Century
						1	1	**1**	H	
						1	1	**1**	H	

7.7 Potable Storage

Portsmouth Water has service reservoirs used for potable storage. The assets are concrete structures and thus have an asset life of 50+ years. The Company has an operating policy of maintaining 48 hours of storage in service reservoirs which enables the Company to accommodate minor and moderate interruptions in abstraction and treatment without causing an interruption in our customers' supply.

7.7.1 Existing Vulnerabilities and Risk Management Mechanisms

Existing vulnerabilities are managed proactively by the Company and a number of measures have been undertaken. Those of significance to climate resilience are listed below:

- monitoring equipment and telemetry established to monitor reservoir levels and water quality

- secondary chlorinators located on reservoir outlets where there is a risk of chlorine depletion in the network

- Flood resilience assessment undertaken in 2009 which found that no service reservoirs are at risk of flooding

- Emergency Plan developed and reviewed annually by Defra

- Water quality risks actively managed through the Drinking Water Safety Plan, signed off by the Drinking Water Inspectorate (DWI)

7.7.2 Expected Impacts of Climate Change

The complete strategic climate change risk assessment for the potable storage function is presented in the table at the end of this section. Further commentary on the assessment is provided below.

7.7.2.1 Sea Level Rise

- *saline intrusion from sea level rise*

  Service reservoirs are situated at high elevations and are therefore not at risk from saline intrusion. The risk is low with a high degree of certainty.

- *asset loss or outage from coastal change*

  Service reservoirs are situated at high elevations and are therefore not at risk from coastal change. The risk is low with a high degree of certainty.

7.7.2.2 Increased Summer Temperatures

- *Reduced operating efficiency of mechanical and electrical equipment*

  Mechanical and electrical (M&E) equipment can be prone to reduced operating efficiency when ambient temperatures rise. The Climate Projections indicate that mean temperatures in August and the hottest day of summer are likely to be 2ºC warmer by the 2030s, and 3-5ºC warmer by the 2080s. M&E equipment used in monitoring is very small and consume very little electricity. The asset life of an M&E monitoring asset is also relatively short.

The risk has therefore been scored as low with high certainty.

- *More extreme wetting and drying cycles leading to accelerated asset deterioration*

  More extreme wetting and drying cycles may lead to accelerated asset deterioration. The risk is considered to be low as it is unlikely to result in significant additional investment being required and is unlikely to compromise service provision. Certainty is high in the near term and medium in the medium and long term.

  The Company collects detailed asset performance data in order to justify capital maintenance activity to Ofwat.

- *Accelerated chlorine depletion*

  Chlorine in the water supply depletes faster at hotter temperatures which leads to an increased risk of bacterial contamination in the water supply. Hotter average and peak temperatures therefore presents a water quality risk. However, this risk is already managed for example through the installation of secondary chlorinators on reservoir outlets.

  The risk is therefore low with a high degree of certainty.

7.7.2.3 Increased Winter Rainfall

- *Increased risk of flooding from groundwater and rivers*

  Flooding may cause ingress in to the treated water and cause an increased risk of bacterial contamination. However, service reservoirs are situated at high elevations and are therefore less at risk from flooding.

  The risk has been scored as low with high certainty.

- *Asset damage from flooding*

  Service reservoirs are situated at high elevations and are therefore less at risk from flooding. The risk has been scored as low with high certainty.

- *Monitoring equipment failure due to flooding*

  Service reservoirs are equipped to monitor water levels and water quality. The assets are situated at high elevations and are therefore less at risk from flooding.

  The risk has been scored as low with high certainty.

7.7.2.4 More Intense Winter Rainfall

- *Increased risk of pluvial flooding*

  Flooding may cause ingress in to the treated water and cause an increased risk of bacterial contamination. However, service reservoirs are situated at high elevations and are therefore less at risk from flooding.

The risk has been scored as low with high certainty.

- *Asset damage from flooding*

  Service reservoirs are situated at high elevations and are therefore less at risk from flooding.

  The risk has been scored as low with high certainty.

- *Monitoring equipment failure due to flooding*

  Service reservoirs are equipped to monitor water levels and water quality. The assets are situated at high elevations and are therefore less at risk from flooding.

  The risk has been scored as low with high certainty.

6. Addressing current and future risks due to climate change - summary (one line is requried per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	Likelihood score (near, medium, long term)	Concsequence score	Risk score (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
Potable storage	Sea level rise	Saline intrusion	3mAOD (screening assessment)	Negligible	Assets at high elevation.	1 1 1	3 3 3	3 3 3	H H H	Not this Century
Potable storage	Sea level rise	Potable storage asset loss or outage		Negligible	Assets at high elevation.	1 1 1	3 3 3	3 3 3	H H H	Not this Century
Potable storage	Increased summer temperatures	Reduced potable storage pump (M&E) efficiency		Negligible	Very low electricity consumption.	1 1 1	1 1 1	1 1 1	H H H	Not this Century
Potable storage	Increased summer temperatures	Accelerated potable storage asset deterioration		Negligible		1 1 1	1 1 1	1 1 1	H H H	Not this Century
Potable storage	Increased summer temperatures	Accelerated chlorine depletion		Low	Existing risk management.	1 1 2	2 2 2	2 2 4	H H H	Long term (late Century)
Potable storage	Increased winter rainfall	Increased flooding leading to ingress and bacterial contamination		Negligible	Assets at high elevation.	1 1 1	3 3 3	3 3 3	H H H	Not this Century
Potable storage	Increased winter rainfall	Increased flooding causing asset damage	1 in 100 year risk (Flood Zone 3)	Negligible	Assets at high elevation.	1 1 1	3 3 3	3 3 3	H H H	Not this Century
Potable storage	More intense winter rainfall	Monitoring equipment failure due to flooding	1 in 100 year risk (Flood Zone 3)	Negligible	Assets at high elevation.	1 1 1	3 3 3	3 3 3	H H H	Not this Century
Potable storage	More intense winter rainfall	Flooding leading to ingress and bacterial contamination		Negligible	Assets at high elevation.	1 1 1	3 3 3	3 3 3	H H H	Not this Century
Potable storage	More intense winter rainfall	Flooding causing asset damage		Negligible	Assets at high elevation.	1 1 1	3 3 3	3 3 3	H H H	Not this Century
Potable storage	More intense winter rainfall	Monitoring equipment failure due to flooding		Negligible	Assets at high elevation.	1 1 1	3 3 3	3 3 3	H H H	Not this Century

7.8 Potable Transport

Overview

Portsmouth Water has significant assets associated with potable transport.

These are comprised of:

- 21 pumping/booster stations for potable transport and associated control equipment
- 3,266 km of distribution network comprised of cast iron, ductile iron, fibre reinforced concrete, PVC, MDPE, HPPE and steel water mains
  - 7 pressure control valves (PCVs)
  - A number of strategic transfer valves (STVs)
- 1 tunnel containing potable water mains entering Portsmouth (Hilsea Tunnel)

The typical asset lives associated with these assets are outlined in the table below.

Asset type	Asset	Asset life (years)
Mechanical and Electrical	Booster pump	15
Mechanical and Electrical	Control equipment	7
Mechanical and Electrical	Generators	15
Civils (concrete structures and buildings)	Concrete channels	50+
Civils (water mains)	Water mains	50+
Mechanical and Electrical	Valves	15

Approximately 3% of our energy consumption is used in pumping potable water.

7.8.1 Existing Vulnerabilities and Risk Management Mechanisms

Existing vulnerabilities are managed proactively by the Company and a number of measures have been undertaken. Those of significance to climate resilience are listed below:

- Significant stand-by electricity generation established for booster pumps to ensure interruptions to mains electricity can be accommodated. These generators are tested on a monthly basis.
- Significant distribution network interconnectivity built over recent decades to accommodate works outage and increase system robustness overall. Appendix 1 shows these strategic links
- Flood Resilience Assessment undertaken in 2009 incorporating all PCVs, STVs and the Hilsea Tunnel
- Asset performance data collected and used to develop the cost-benefit case of capital maintenance activity to the financial regulator, Ofwat, on a five-yearly basis
  - Approximately 1% of our distribution network renewed annually
  - Emergency Plan developed and reviewed annually by Defra

- Water quality risks actively managed through the Drinking Water Safety Plan, signed off by the Drinking Water Inspectorate (DWI)

Further information is provided below.

7.8.1.1 Electricity Supply Security

Diesel powered standby electricity generation has been established at 12 out of 21 booster stations.

The Company also has a number of mobile (portable) electricity generators to cover the remaining sites.

7.8.1.2 Flooding

A Flood Resilience Assessment of Company assets and sites was undertaken in 2009 which included all PCVs, STVs and the Hilsea Tunnel. The assessment utilised both the Environment Agency Flood Zone Mapping and the Company's own experience of flooding events. High risk sites are defined as those within Flood Zone 3, vulnerable to a 1 in 100 year fluvial and/or a 1 in 200 year coastal flooding event. Low risk sites are defined as those within Flood Zone 2, vulnerable to a 1 in 1000 year flooding event. The results of the assessment showed that:

- 1 booster station is located within the high risk zone
- all STVs are not at risk of flooding
- three out of eight electrically operated PCVs are in the high risk zone
- the Hilsea Tunnel is in the high risk zone

The booster affected is located at the Lavant works which will have flood resilience improvements undertaken during AMP 5.

In some circumstances, the Company has installed Uninterruptible Power Supplies (UPS systems) on PCVs which enable the valves to open automatically, thus maintaining the security of customers' supplies. The Company does not expect the operation of mechanically controlled PCVs to be impacted by flooding. No further investment is proposed at this stage.

The Hilsea Tunnel takes two trunk mains from the mainland to serve Portsmouth on Portsea Island. Both access shafts are in the flood risk zone however each has covers raised above the surrounding ground. Since the trunk mains are expected to be under positive head no risk to supplies is anticipated if the tunnel shafts were to be flooded. Both shafts are already equipped with sump pumps to deal with surface water ingress.

The Executive Summary from the Flood Resilience Assessment 2009 is included in Appendix 2 and the Flood Mapping is included in Appendix 3.

The Company has also recently improved its digital mapping system to make better use of third party data, including the Environment Agency's coastal and river flood risk maps and surface water flood risk maps across its operational area. Analysis of this data and the findings from the Flood Resilience Assessment are of use in informing the flood management aspects of our Emergency Plan, which covers emergencies which affect our customers. The Company will also continue to review new flood risk mapping information from the Environment Agency when it becomes available.

7.8.2 Expected Impacts of Climate Change

The complete climate change risk assessmenton the potable transportation function is presented in the table at the end of this section. Further commentary on the assessment isprovided below.

7.8.2.1 Sea level rise

- *saline intrusion of water mains from sea level rise leading to water quality risk*

  Some of our mains situated near the coast may become at risk from saline intrusion. Water is transported through the mains under pressure during normal operations, which prevents infiltration into the system. In the event of mains pressure loss or an interruption to supply, the system is isolated and sterilised before service to our customers is restored. Ductile iron, cast iron and steel mains are considered to be more at risk as metallic mains are more susceptible to saline attack. However the likelihood is still considered to be low in the near and medium term. Long term risks are considered to be moderate, with uncertainty in the likelihood assessment.

  Fibre reinforced concrete, PVC, MDPPE and HPPE mains are not considered to be vulnerable to saline intrusion.

- *Population migration away from areas at risk of coastal change; network sizing inappropriate*

  Population migration away from coastal change is not expected to be significant in the Company's area of supply due to the prevalence of the 'Hold the Line' policy in shoreline management. Additionally, the consequences for network sizing would be low as the developer would pay for any required upgrading.

  Therefore, risks are considered to be low with high certainty.

- *Asset loss (water mains) due to coastal change*

  Loss of water mains asset loss is not expected to be a significant risk in the near, medium or long term, with high certainty. This is due to the prevalence of the Hold the Line policy in shoreline management. In addition, mains diversion is part of normal Company operations; for example we have recently undertaken a mains diversion due to a new public transport route in Gosport.

  Risks are therefore scored as low with high certainty.

7.8.2.2 Increased Summer Temperatures

- *Reduced operating efficiency of M&E equipment*

  Motor equipment can be prone to reduced operating efficiency when ambient temperatures rise. The Climate Projections indicate that mean temperatures in August and the hottest day of summer are likely to be 2ºC warmer by the 2030s, and 3-5ºC warmer by the 2080s. Limited energy is used by the Company in potable transport, therefore the consequences of reduced efficiency are considered to be low. The asset life of the equipment involved is also relatively short.

The risk has therefore been scored as low with high certainty.

- *More extreme wetting and drying cycles leading to accelerated asset deterioration*

  More extreme wetting and drying cycles may lead to accelerated asset deterioration. Below ground assets are particularly at risk as they are more susceptible to earth movement. The current burst rate of the Company is 340 per year, and an increase in the burst rate would indicate a deteriorating asset stock.

  The risk to cast iron mains is considered to be low in the near term, but rising to high in the long term, with medium certainty.

  Ductile iron, fibre reinforced concrete, PVC and steel mains are less susceptible than cast iron to earth movement, however it still presents an issue. Long term risks from climate change are therefore scored as medium.

  MDPPE and HPPE are not considered to be at significant risk from additional climate-change driven earth movement, with a high degree of certainty.

  The Company collects detailed asset performance data in order to justify capital maintenance activity to Ofwat.

- *Accelerated chlorine depletion*

  Chlorine in the water supply depletes faster at hotter temperatures which leads to an increased risk of bacterial contamination in the water supply. Hotter average and peak temperatures therefore presents a water quality risk. However, this risk is already managed for example through the installation of secondary chlorinators on service reservoir outlets.

  The risk is therefore low with a high degree of certainty.

- *Increased seasonal (tourist) population; network sizing is insufficient*

  Consumption of water is limited by supply size. Network reinforcement costs are incorporated into the infrastructure charge for upgrading water supplies. Therefore the consequence is low, and the overall risk is low with a high degree of certainty.

- Increased occurrence of heat wave events; road melt impedes routine mains repair

  The risk is considered to below throughout the century.

7.8.2.3 Increased Winter Temperatures

- *Reduction in mains bursts associated with frozen earth (climate change opportunity)*

  Projections indicate that average winter temperatures and the temperature of the coldest night of winter are expected to rise, and that there will be a reduction in the number of frost days.

Bursts in water mains typically peak during and following a cold snap, as frozen and thawing earth causes significant earth movement, leading to asset failure. An increase in the winter temperature minima and a reduction in the number of frost days may lead to a reduction in mains bursts associated with cold weather.

7.8.2.4 Increased winter rainfall

- *Increased regional flooding; infiltration of below ground assets*

  Below ground assets are not considered to be at risk from flooding.

- *Increased flood risk to pumps, valves etc (above ground assets*

  Above ground assets associated with potable water transport were included in the 2009 Flood Resilience Assessment. There near term risk is therefore low with a high degree of confidence, however, the long term risk has been scored as medium due to increased likelihood of flooding in the future. Certainty in this assessment is medium.

- *Population migration away from areas at risk; network sizing inappropriate*

  Population migration away from areas at risk of flooding is not expected to be significant, as highlighted in the North Solent Catchment Flood Management Plan. Additionally, network sizing consequences would be low as any infrastructure upgrade required for new developments are currently funded by the developer.

  Risks are therefore considered to be low with a high degree of confidence.

- *Regional flooding impeding routine mains repair*

  The risk of regional flooding impeding mains repair is currently acceptable but expected rise to medium in the long term, as flooding becomes more frequent. Certainty in this assessment is low.

7.8.2.5 More Intense Winter Rainfall

- *Increased regional flooding; infiltration of below ground assets*

  Below ground assets are not considered to be at risk from flooding.

- *Increased flood risk to pumps, valves etc (above ground assets*

  Above ground assets associated with potable water transport were included in the 2009 Flood Resilience Assessment. Pluvial flooding events pass quickly, therefore the impacts are considered to be relatively minor to Company operations.

  Risks are therefore scored as low with reduced confidence with time.

- *Population migration away from areas at risk; network sizing inappropriate*

  Risks are scored as low as the likelihood of significant population migration is low, and the consequence is low where new developments are constructed, the developer pays for any required upgrades to the network.

- *Regional flooding impeding routine mains repair*

  The risk of regional flooding impeding mains repair is currently acceptable but may rise. Pluvial events can pass quickly therefore the consequence for mains repair is low. The overall risk has therefore been scored as low, with rising uncertainty.

7.8.2.6 Increased Storminess

- *Increased interruptions to electricity supply*

  The risk is considered to be low as the Company has significant standby generation facilities and operational policies that enable outage to be accommodated.

- *Increased interruptions to telecommunications and telemetry*

  Interruptions to telecommunications to our booster stations occur relatively frequently to our potable booster stations, due to the remote locations of some assets. The Company has back up systems in place for critical data monitoring. Risks are considered low in the near term, rising to medium in the medium and long term.

The strategic climate change risk assessment is presented in the table below.

6. Addressing current and future risks due to climate change - summary (one line is required per risk)										
Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	**Likelihood score** (near, medium, long term)	**Consequence score**	**Risk score** (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
Potable transport	Sea level rise	Saline intrusion of water mains (metallic mains)		Low	Cast iron, ductile iron and steel susceptible to saline attack. Coastal assets at risk.	1 1 2	3 3 3	3 3 6	H M L	Long term (late Century)
Potable transport	Sea level rise	Saline intrusion of water mains (non-metallic mains)		Negligible	Fibre reinforced concrete, PVC, MDPPE, HPPE not susceptible to saline attack.	1 1 1	3 3 3	3 3 3	H H H	Not this Century
Potable transport	Sea level rise	Population migration away from coastal risk; network sizing inappropriate		Negligible	Hold the Line policy prevalent in populated areas. In network requires upgrading due to new developments, the developer pays.	1 1 1	2 2 2	2 2 2	H H H	Not this Century
Potable transport	Sea level rise	Asset loss (water mains) due to coastal change		Negligible	Not rapid erosion in our area. Mains divergence as part of regional infrastructure change (e.g. transport routes) is part of normal operations.	1 1 1	2 2 2	2 2 2	H M M	Not this Century
Potable transport	Increased summer temperatures	Reduced potable transport pump (M&E) efficiency		Negligible	Only 3% of energy used in potable transport.	1 1 1	1 1 1	1 1 1	H H H	Not this Century
Potable transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration (above ground assets)		Negligible	Very unlikely to lead to significant deterioration of pumping assets. Asset performance data collected. Consequence are low, only slightly shortened asset life.	1 1 1	1 1 1	1 1 1	H H H	Not this Century
Potable transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration (below ground assets - cast iron)		High	Cast iron most at risk from earth movement and asset deterioration.	1 3 4	4 4 4	4 12 16	H M M	Medium term (mid-Century)
Potable transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration below ground assets - ductile iron, fibre reinforced concrete, PVC and steel)		Medium	Ductile iron, fibre reinforced concrete, PVC and steel at moderate at risk from earth movement and asset deterioration.	1 2 3	4 4 4	4 8 12	H M M	Near term (within 20-30 years)
Potable transport	Increased summer temperatures	More extreme wetting and drying cycles leading to accelerated asset deterioration (below ground assets - MDPPE and HPPE)		Negligible	MDPPE and HPPE not at risk from earth movement and asset deterioration.	1 1 1	4 4 4	4 4 4	H H H	Not this Century
Potable transport	Increased summer temperatures	Accelerated chlorine depletion			Existing risk management.	1 1	2 2	2 2	H H	Long term (late Century)

6. Addressing current and future risks due to climate change - summary (one line is required per risk)

Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	Likelihood score (near, medium, long term)	Consequence score	Risk score (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
						2	2	4	M	
Potable transport	Increased summer temperatures	Increased seasonal (tourist) population; network sizing is insufficient			Impact is incremental and upgrading of supply sizes is paid for in the infrastructure charge.	1 1 1	2 2 2	2 2 2	H H H	Not this Century
Potable transport	Increased summer temperatures	Increased heat wave events; road melt impedes routine mains repair		Low	Requires heatwave to coincide with burst main.	1 1 2	1 2 2	1 2 4	H H M	Not this Century
Potable transport	Increased winter temperatures	Reduction in mains failure associated with cold weather (climate change opportunity)				N/A N/A N/A	N/A N/A N/A	N/A N/A N/A	N/A N/A N/A	
Potable transport	Increased winter rainfall	Increased regional flooding; infiltration of below ground assets		Low	Water mains at positive head. Below ground assets not expected to be affected in 2009 flood risk assessment.	1 1 2	1 2 2	1 2 4	H H M	Long term (late Century)
Potable transport	Increased winter rainfall	Increased flooding to potable pumps		Medium	The Company has a comprehensive understanding of current flood risks to abstraction assets. We expect winter-spring groundwater levels to rise under climate change which will increase groundwater flooding risk.	1 2 3	3 3 3	3 6 9	H M M	Medium term (mid-Century)
Potable transport	Increased winter rainfall	Population migration away from flood risk; network sizing inappropriate		Negligible	Developer pays for new water infrastructure. Migration not expected to be significant.	1 1 1	1 1 1	1 1 1	H H H	Not this Century
Potable transport	Increased winter rainfall	Increased regional flooding; impedes routine mains repair		Medium	Risk currently acceptable but expected to rise	1 2 3	3 3 3	3 6 9	H M L	Medium term (mid-Century)
Potable transport	Increased winter rainfall	Population migration away from flood risk; network sizing inappropriate		Negligible	Developer pays for new water infrastructure. Migration not expected to be significant.	1 1 1	1 1 1	1 1 1	H H H	Not this Century
Potable transport	More intense winter rainfall	Increased regional flooding; infiltration of below ground assets		Negligible	Flooding not a significant risk for below ground assets (2009 FRA)	1 1 1	1 1 1	1 1 1	H H H	Not this Century
Potable transport	More intense winter rainfall	Increased flooding to pumps			All above ground assets assessed in 2009 FRA. Due to chalk geology, pluvial risk is not expected to increase dramatically. Events pass quickly.	1 1 2	2 2 2	2 2 4	H H M	Long term (late Century)
Potable transport	More intense winter rainfall	Increased regional flooding; impedes routine mains repair		Low	Risk currently acceptable but expected to rise. Not significantly however (CFMP)	1 1	2 2	2 2	H M	Medium term (mid-Century)

6. Addressing current and future risks due to climate change - summary (one line is required per risk)										
Business Function	Climate Variable	Primary Impact of climate variable	Thresholds above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Justification	**Likelihood score** (near, medium, long term)	**Consequence score**	**Risk score** (near, medium, long term)	Certainty	Timescale over which risks are expected to materialise and action planned
						2	2	**4**	L	
Potable transport	Increased storminess	Increased interruptions to electricity supply		Low	The Company has significant standby generation and support systems.	1	1	**1**	H	Long term (late Century)
						1	1	**1**	H	
						2	1	**2**	H	
Potable transport	Increased storminess	Increased interruptions to telecommunications and telemetry			Remote sites are more susceptible. Back-up systems are in place for critical data.	1	3	**3**	H	Medium term (mid-Century)
						1	3	**3**	M	
						2	3	**6**	M	

8. RISK ASSESSMENT FINDINGS

The following tables summarise the findings from the detailed risk assessment described in Section 7. Results are presented on a likelihood-consequence matrix for the near (0-30 years), medium (30-60 years) and long (60+ years) term.

Where possible, risks are grouped for clarity of message. For example, 'population migration away from flood risk' represents both fluvial and pluvial flood risks, which are listed under separate climate drivers (increased winter rainfall and more intense rainfall respectively) in Section 7. The risks were assigned the same likelihood and consequence scores, therefore combining them does not reduce granularity of risk data. Likewise, impacts on peak demand for water from the two separate climate drivers of reduced summer rainfall and increased summer temperatures, are also combined as they were scored equally in Section 7.

Increased interruptions to electricity supply and interruptions to telecoms and telemetry is listed under its highest risk rating, rather than listing multiple times for each business function.

The matrices show that the Company has no high priority climate risks in the near term, as all existing and near term climate and weather related risks have been addressed through water resources management planning, drought planning, water quality risk management and resilience improvements and general reinforcing.

Risks rise with time, as illustrated in the matrices.

Increased risk of environmental flow requirements in water courses, reducing reliability of sources for public water supply, is considered to be a medium risk in the near term, as the Company does not feel that this risk is adequately reflected in current headroom.

All other climate risks to assets, service and operations are considered to be low in the near term.

Near Term Risks from Climate Change

NEAR TERM RISKS	CONSEQUENCE SCORE				
LIKELIHOOD SCORE	**1**	**2**	**3**	**4**	**5**
5					-
4					
3			• Increased risk of breach of environmental flow requirements in water courses, reducing reliability of sources for public water supply		
2		• Increased biological growth in river (driven by reduced cloud cover) • Higher temperatures cause increased biological and bacterial growth in river water • Lower river flows cause warmer water and increased biological and bacterial growth			
1	• Increased soil compaction, reducing aquifer recharge • Treatment asset loss or outage from coastal change • Increased biological growth in rapid gravity filters and clarifiers • Floodwater infiltration (pluvial) of potable water mains • Disturbance of flocculant blanket in treatment (storminess) • Abstraction assets loss or outage from coast change • Population migration away from flood risk; network sizing inappropriate • Accelerated asset deterioration of: - raw and potable water storage assets - potable boosters • Reduced potable transport (M&E) efficiency • Reduced treatment pump (M&E) efficiency • Increased interruptions to electricity supply • Road melt events impede access to abstraction works and raw water boosters	• Water resources asset loss from coastal change • Saline intrusion of Havant and Bedhampton Springs source • River Itchen intake too high due to low flows • Increased evapotranspiration reduces aquifer recharge • Population migration away from coastal change disrupting the supply-demand balance • Population migration away from flood risk disrupting the supply demand balance • Population migration away from coastal change; network sizing inappropriate • Increased seasonal (tourist) population; network sizing inappropriate • Increased turbidity events from runoff (river and springs sources) • Bacterial growth in rapid gravity filters • Floodwater (fluvial and groundwater) infiltration of potable water mains • Accelerated chlorine depletion at higher temperatures • Reduced abstraction pump (M&E) efficiency • Reduced raw water transportation pump (M&E) efficiency • Accelerated asset deterioration (wetting and drying cycles) of: - Abstraction assets - raw water boosters - treatment assets • Increased pluvial flooding to raw water storage asset • Increased pluvial flood risk to - source works - treatment works - pumping stations (raw and potable) • Increased regional pluvial flooding and heatwaves impede mains repair activities • Increased road melt events impede treatment works access • Chemical supply chains disrupted by heatwaves and floods • Increased storm damage to buildings and overhead cabling • Water mains asset loss due to coastal change	• Reduced aquifer recharge during summer months leads to reduced source yield in October • Increased summer abstraction in catchments by: - other (existing) abstractors, including unlicensed - new agricultural abstractors • Increased demand from net inward migration of retirement population • Lower river flows cause higher contaminants concentrations • Increased bacterial growth in rapid gravity filters • Increased flooding to raw water storage assets from rivers and groundwater • Increased flooding to source and treatment works from rivers and groundwater • Increased flooding to pumping stations (raw and potable) from rivers and groundwater • Increased regional flooding from rivers and groundwater impedes mains repair activity • Saline intrusion of service reservoirs • Infiltration of service reservoirs from flooding • Service reservoir monitoring equipment failure due to flooding • Asset loss or outage of service reservoirs from coastal change • Saline intrusion of water mains (metallic mains) • Saline intrusion of water mains (non-metallic mains) • Accelerated asset deterioration of raw water mains • Increased interruptions to telecommunications and telemetry (driven by floods and storms)	• Accelerated asset deterioration of cast iron water mains (wetting and drying cycles; earth movement) • Accelerated asset deterioration of ductile iron, fibre reinforced concrete, PVC and steel water mains (driven by wetting and drying cycles / earth movement) • Accelerated asset deterioration of MDPPE and HPPE water mains (wetting and drying cycles; earth movement) • Saline intrusion from lower groundwater / increased abstraction • Raw water boosters asset loss from coastal change • Saline intrusion of raw water mains • Saline intrusion of borehole sources	• Rising salinity at River Itchen intake • Reduced aquifer recharge during summer months leads to reduced summer source yield • Increased demand for water at peak from: - permanent population driven by reduced summer rainfall and higher summer temperatures - seasonal (tourist) population increase • Increased occurrence of drought

Medium Term Risks from Climate Change

MEDIUM TERM RISKS		CONSEQUENCE SCORE 1	2	3	4	5
LIKELIHOOD SCORE	5					-
	4		• Increased biological growth in river (driven by reduced cloud cover)			
	3		• Higher temperatures cause increased biological and bacterial growth in river water • Lower river flows cause warmer water and increased biological and bacterial growth	• Increased risk of breach of environmental flow requirements in water courses, reducing reliability of sources for public water supply • Increased summer abstraction in catchments by: - other (existing) abstractors, including unlicensed - new agricultural abstractors • Increased demand from net inward migration of retirement population • Increased flooding to source and treatment works from rivers and groundwater	• Accelerated asset deterioration of cast iron water mains (wetting and drying cycles; earth movement)	• Increased demand for water at peak from: - permanent population driven by reduced summer rainfall and higher summer temperatures - seasonal (tourist) population increase • Increased occurrence of drought
	2	• Reduced treatment pump (M&E) efficiency	• Increased evapotranspiration reduces aquifer recharge • Increased turbidity events from runoff (river and springs sources) • Increased road melt events impede treatment works access • Chemical supply chains disrupted by heatwaves and floods	• Lower river flows cause higher contaminants concentrations • Increased regional flooding from rivers and groundwater impedes mains repair activity • Increased flooding to pumping stations (raw and potable) from rivers and groundwater	• Accelerated asset deterioration of ductile iron, fibre reinforced concrete, PVC and steel water mains (driven by wetting and drying cycles / earth movement)	
	1	• Increased soil compaction, reducing aquifer recharge • Treatment asset loss or outage from coastal change • Increased biological growth in rapid gravity filters and clarifiers • Floodwater infiltration (pluvial) of potable water mains • Disturbance of flocculant blanket in treatment (storminess) • Abstraction assets loss or outage from coast change • Population migration away from flood risk; network sizing inappropriate • Accelerated asset deterioration of: - raw and potable water storage assets - potable boosters • Reduced potable transport (M&E) efficiency • Increased interruptions to electricity supply • Road melt events impede access to abstraction works and raw water boosters	• Water resources asset loss from coastal change • Saline intrusion of Havant and Bedhampton Springs source • River Itchen intake too high due to low flows • Population migration away from coastal change disrupting the supply-demand balance • Population migration away from flood risk disrupting the supply demand balance • Population migration away from coastal change; network sizing inappropriate • Increased seasonal (tourist) population; network sizing inappropriate • Bacterial growth in rapid gravity filters • Floodwater (fluvial and groundwater) infiltration of potable water mains • Accelerated chlorine depletion at higher temperatures • Reduced abstraction pump (M&E) efficiency • Reduced raw water transportation pump (M&E) efficiency • Accelerated asset deterioration (wetting and drying cycles) of: - Abstraction assets - raw water boosters - treatment assets • Increased pluvial flooding to raw water storage asset • Increased pluvial flood risk to - source works - treatment works - pumping stations (raw and potable) • Increased regional pluvial flooding and heatwaves impede mains repair activities • Increased storm damage to buildings and overhead cabling • Water mains asset loss due to coastal change	• Reduced aquifer recharge during summer months leads to reduced source yield in October • Increased bacterial growth in rapid gravity filters • Increased flooding to raw water storage assets from rivers and groundwater • Saline intrusion of service reservoirs • Infiltration of service reservoirs from flooding • Service reservoir monitoring equipment failure due to flooding • Asset loss or outage of service reservoirs from coastal change • Saline intrusion of water mains (metallic mains) • Saline intrusion of water mains (non-metallic mains) • Accelerated asset deterioration of raw water mains • Increased interruptions to telecommunications and telemetry (driven by floods and storms)	• Accelerated asset deterioration of MDPPE and HPPE water mains (wetting and drying cycles; earth movement) • Saline intrusion from lower groundwater / increased abstraction • Raw water boosters asset loss from coastal change • Saline intrusion of raw water mains • Saline intrusion of borehole sources	• Rising salinity at River Itchen intake • Reduced aquifer recharge during summer months leads to reduced summer source yield

Long Term Risks from Climate Change

LONG TERM RISKS	CONSEQUENCE SCORE 1	2	3	4	5
LIKELIHOOD SCORE 5		• Increased biological growth in river (driven by reduced cloud cover)	• Increased demand from net inward migration of retirement population		• Increased demand for water at peak from: - permanent population driven by reduced summer rainfall and higher summer temperatures - seasonal (tourist) population increase
4		• Higher temperatures cause increased biological and bacterial growth in river water	• Increased risk of breach of environmental flow requirements in water courses, reducing reliability of sources for public water supply • Increased summer abstraction in catchments by: - other (existing) abstractors, including unlicensed - new agricultural abstractors • Lower river flows cause higher contaminants concentrations • Increased flooding to source and treatment works from rivers and groundwater	• Accelerated asset deterioration of cast iron water mains (wetting and drying cycles; earth movement)	• Increased occurrence of drought
3	• Reduced treatment pump (M&E) efficiency	• Chemical supply chains disrupted by heatwaves and floods • Lower river flows cause warmer water and increased biological and bacterial growth • Increased road melt events impede treatment works access	• Increased regional flooding from rivers and groundwater impedes mains repair activity • Increased flooding to pumping stations (raw and potable) from rivers and groundwater	• Accelerated asset deterioration of ductile iron, fibre reinforced concrete, PVC and steel water mains (driven by wetting and drying cycles / earth movement)	
2	• Abstraction assets loss or outage from coast change • Increased interruptions to electricity supply • Disturbance of flocculant blanket in treatment (storminess) • Road melt events impede access to abstraction works and raw water boosters	• Water resources asset loss from coastal change • Increased evapotranspiration reduces aquifer recharge • Population migration away from flood risk disrupting the supply demand balance • Increased turbidity events from runoff (river and springs sources) • Floodwater (fluvial and groundwater) infiltration of potable water mains • Accelerated chlorine depletion at higher temperatures • Increased pluvial flood risk to - source works - treatment works - pumping stations (raw and potable) • Increased regional pluvial flooding and heatwaves impede mains repair activities • Increased storm damage to buildings and overhead cabling • Accelerated abstraction asset deterioration • Reduced raw water transportation pump (M&E) efficiency at higher temperatures	• Saline intrusion of water mains (metallic mains) • Increased interruptions to telecommunications and telemetry (driven by floods and storms)	• Saline intrusion of borehole sources	
1	• Increased soil compaction, reducing aquifer recharge • Treatment asset loss or outage from coastal change • Increased biological growth in rapid gravity filters and clarifiers • Floodwater infiltration (pluvial) of potable water mains • Population migration away from flood risk; network sizing inappropriate • Accelerated asset deterioration of: - raw and potable water storage assets - potable boosters • Reduced potable transport (M&E) efficiency	• Saline intrusion of Havant and Bedhampton Springs source • River Itchen intake too high due to low flows • Population migration away from coastal change disrupting the supply-demand balance • Population migration away from coastal change; network sizing inappropriate • Increased seasonal (tourist) population; network sizing inappropriate • Bacterial growth in rapid gravity filters • Reduced abstraction pump (M&E) efficiency • Accelerated asset deterioration (wetting and drying cycles) of: - raw water boosters - treatment assets • Increased pluvial flooding to raw water storage asset • Water mains asset loss due to coastal change	• Reduced aquifer recharge during summer months leads to reduced source yield in October • Increased bacterial growth in rapid gravity filters • Increased flooding to raw water storage assets from rivers and groundwater • Saline intrusion of service reservoirs • Infiltration of service reservoirs from flooding • Service reservoir monitoring equipment failure due to flooding • Asset loss or outage of service reservoirs from coastal change • Saline intrusion of water mains (non-metallic mains) • Accelerated asset deterioration of raw water mains	• Accelerated asset deterioration of MDPPE and HPPE water mains (wetting and drying cycles; earth movement) • Saline intrusion from lower groundwater / increased abstraction • Raw water boosters asset loss from coastal change • Saline intrusion of raw water mains	• Rising salinity at River Itchen intake • Reduced aquifer recharge during summer months leads to reduced summer source yield

9. PRIORITY AREAS FOR ACTION

Portsmouth Water operates a risk management system which is reviewed at least annually by the Board of Directors. The Company's risk register is reviewed on a monthly basis by the senior management team at the Management Board. Risks identified as a result of climate change will be recorded on the Company's risk register. In addition, specific items relating to climate change are included as a Board item as appropriate. Portsmouth Water's activities are ultimately related to public health and consequently the approach to risk is a precautionary one.

This section sets out the priority areas for action in climate change risk management that the Company has identified. Risks in this section are grouped according to the four principle risk management mechanisms used across the Company to enable climate change risks to be incorporated in to existing business risk management processes and implement an operational response if required.

These risk management mechanisms are:

(1) Capital Planning

Capital Planning incorporates asset performance and failure data monitoring, decision making functions and investment planning.

(2) Drinking Water Safety Plan

The Drinking Water Safety Plan is the operational risk management tool for managing water quality risks from catchment to tap.

(3) Water Resources Management Planning and Drought Planning

Strategic risks to the supply/demand balance are managed through the Statutory Water Resources Management Plan process. The objective is to set out a twenty five year, least cost, plan to ensure that a certain level of service is maintained. If the return period of an event exceeds the level of service then the Drought Plan will be implemented instead.

The more extreme risks to the supply/demand balance are managed through the statutory Drought Plan process. Drought Plans are produced on a three yearly cycle and so the next plan will be developed at the end of 2011.

(4) Resilience and Emergency Planning

Resilience and Emergency Planning is the process of reviewing the vulnerability of Company assets and operations to extreme events such as floods, heat waves and storms, and instigating measures (either capital or operational) where necessary.

The Emergency Plans cover any emergency event that may affect our customers, including weather events. The Plans are audited annually by Defra.

9.1 Climate Risks Managed Through Capital Planning

9.1.2 Risks

Risks to asset performance, such as pump (M&E) efficiency, and risks to asset life, such as accelerated asset deterioration, were generally assessed as low with two exceptions:

- Accelerated asset deterioration of cast iron water mains from more extreme wetting and drying cycles and earth movement

- Accelerated asset deterioration of ductile iron, fibre reinforced concrete, PVC and steel water mains from more extreme wetting and drying cycles and earth movement

In both cases the near term risk is low, however the risks rise in the medium and long term as shown in the Tables.

9.1.3 Opportunities

Warmer winters, specifically an increase in temperature of the coldest night and day of winter, may lead to a reduction in water mains failure (bursts) associated with cold weather and earth movement.

Risk management mechanism	Business function	Risk score (near term)	Risk score (medium term)	Risk score (long term)	Risk description	Action	Validation
Capital Planning	Potable transport	4	12	16	Accelerated asset deterioration of cast iron water mains from more extreme wetting and drying cycles and earth movement	Near term risk is low. Review case in AMP 6 for incorporating climate change impacts in to asset deterioration modelling, and consider future climates when procuring replacement assets.	Continue to monitor asset performance data for capital maintenance planning.
Capital Planning	Potable transport	4	8	12	Accelerated asset deterioration of ductile iron, fibre reinforced concrete, PVC and steel water mains from more extreme wetting and drying cycles and earth movement	Near term risk is low. Review case in AMP 6 for incorporating climate change impacts in to asset deterioration modelling, and consider future climates when procuring replacement assets.	Continue to monitor asset performance data for capital maintenance planning.
Capital Planning	Abstraction	2	2	4	Accelerated abstraction asset deterioration (from wetting and drying cycles)	Consider future climates when procuring new or replacement long term assets.	Continue to monitor asset performance data for capital maintenance planning.
Capital Planning	Abstraction	2	2	4	Abstraction asset loss or outage from coastal change	No action required on existing assets. Consider risk when developing new assets. Review next round of coastal change projections and management policies. Continued engagement with regional planners.	Existing raw water quality monitoring will identify any salinity events.
Capital Planning	Raw transport	2	2	4	Reduced raw water transportation pump (M&E) efficiency	No action required on existing assets. Consider future temperature exposure when procuring replacement assets.	Continue to monitor asset performance and energy data.
Capital Planning	Potable transport	4	4	4	Accelerated asset deterioration of MDPPE and HPPE water mains (wetting and drying cycles; earth movement)	Consider future climates when developing new or replacement long term assets.	Continue to monitor asset performance data for capital maintenance planning.
Capital Planning	Raw transport	4	4	4	Raw water boosters asset loss from coastal change	Consider future climates when developing new or replacement long term assets. Review next round of coastal change projections and management policies. Continued engagement with regional planners.	Continue to monitor asset performance data.

Risk management mechanism	Business function	Risk score (near term)	Risk score (medium term)	Risk score (long term)	Risk description	Action	Validation
Capital Planning	Treatment	1	2	3	Reduced treatment pump (M&E) efficiency	No action required on existing assets. Consider future temperature exposure when procuring replacement assets.	Continue to monitor asset performance and energy data.
Capital Planning	Potable storage	3	3	3	Asset loss or outage of service reservoirs from coastal change	Consider future climates when developing new or replacement long term assets.	Review next round of coastal change projections and management policies. Continued engagement with regional planners.
Capital Planning	Potable transport	2	2	2	Population migration away from coastal change (network sizing)	Consider future climates when developing new or replacement long term assets.	Review next round of coastal change projections and management policies. Continued engagement with regional planners.
Capital Planning	Abstraction	2	2	2	Reduced abstraction pump (M&E) efficiency	No action required on existing assets. Consider future temperature exposure when procuring replacement assets.	Continue to monitor asset performance and energy data.
Capital Planning	Abstraction	2	2	2	River Itchen intake too high due to low flows	No action required.	Continue to monitor intake yields.
Capital Planning	Raw transport	2	2	2	Accelerated asset deterioration of raw water booster assets (wetting and drying cycles)	Consider future climates when developing new or replacement long term assets.	Continue to monitor asset performance data for capital maintenance planning.
Capital Planning	Treatment	2	2	2	Accelerated deterioration of treatment assets (wetting and drying cycles)	Consider future climates when developing new or replacement long term assets.	Continue to monitor asset performance data for capital maintenance planning.
Capital Planning	Potable transport	2	2	2	Potable water mains asset loss due to coastal change	Consider future climates when developing new or replacement long term assets.	Review next round of coastal change projections and management policies. Continued engagement with regional planners.
Capital Planning	Potable transport	2	2	2	Increased seasonal (tourist) population (network sizing)	No action required.	Undertake network reinforcement as required.
Capital Planning	Raw transport	1	1	1	Accelerated deterioration of raw water and potable storage assets (wetting and drying cycles)	Consider future climates when developing new or replacement long term assets.	Continue to monitor asset performance data for capital maintenance planning.
Capital Planning	Treatment	1	1	1	Treatment asset loss or outage from coastal change	Consider future climates when developing new or replacement long term assets.	Review next round of coastal change projections and management policies. Continued engagement

Risk management mechanism	Business function	Risk score (near term)	Risk score (medium term)	Risk score (long term)	Risk description	Action	Validation
							with regional planners.
Capital Planning	Potable storage, potable transport	1	1	1	Reduced potable storage and potable transport pump (M&E) efficiency	No action required on existing assets. Consider future temperature exposure when procuring replacement assets.	Continue to monitor asset performance and energy data.
Capital Planning	Potable transport	1	1	1	Accelerated deterioration of potable transport assets (wetting and drying cycles)	Consider future climates when developing new or replacement long term assets.	Continue to monitor asset performance data for capital maintenance planning.
Capital Planning	Potable transport	1	1	1	Population migration away from flood risk (network sizing)	No action required.	Undertake network reinforcement as required.

9.2 Climate Risks Managed Through Drinking Water Safety Planning

9.2.1 Risks

Risks to water quality driven by climate change were assessed as low in the near term. Water quality is intimately linked with weather, however, existing weather and climate risks are managed by the Company through the Drinking Water Safety Plan and the overall risk is currently low. The Company is also undertaking roof construction work during AMP 5 where there has been a recurrent algal growth problem.

In the medium term, four strategic risks were assessed as moderate. These are:

- Lower river flows cause high contaminant concentrations
- Reduced cloud cover leads to increased biological growth in the river
- Higher temperatures cause increased biological and bacterial growth in river
- Lower river flows cause warmer water and increased biological and bacterial growth in river.

Two further risks were also identified which may impact the Company in the long term:

- Saline intrusion of potable water mains (metallic mains)
- Chemical supply chain disruption from regional heatwaves and floods

9.2.2 Opportunities

No opportunities to water quality risk management were identified.

Risk management mechanism	Business function	Risk score (near term)	Risk score (medium term)	Risk score (long term)	Risk description	Action	Validation
DWSP	Raw water quality	3	6	12	Lower river flows cause higher contaminant concentrations	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Raw water quality	4	8	10	Reduced cloud cover leads to increased biological growth in river	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Raw water quality	4	6	8	Higher temperatures cause increased biological and bacterial growth in river	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Raw water quality	4	6	6	Lower river flows cause warmer water and increased biological and bacterial growth in river	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Treatment	2	4	6	Chemical supply chain disruption from regional heatwaves and floods	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Potable transport	3	3	6	Saline intrusion of potable water mains (metallic mains)	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Raw transport (water quality)	4	4	4	Saline intrusion of raw water mains (water quality risk)	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Raw water quality	2	4	4	Increased turbidity events from runoff (river and springs sources)	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Potable transport and storage (water quality)	2	2	4	Accelerated chlorine depletion in treated water (potable storage and transportation)	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.

Risk management mechanism	Business function	Risk score (near term)	Risk score (medium term)	Risk score (long term)	Risk description	Action	Validation
DWSP	Potable transport (water quality)	2	2	4	Regional flooding from groundwater and rivers causes infiltration of water mains; bacterial contamination risk	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Treatment	3	3	3	Increased bacterial growth in rapid gravity filters	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Potable storage (water quality)	3	3	3	Saline intrusion of service reservoirs	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Potable storage (water quality)	3	3	3	Infiltration of service reservoirs from flooding	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Raw storage (water quality)	3	3	3	Increased flooding to raw water storage assets from rivers and groundwater; bacterial contamination, asset damage	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Treatment	1	1	2	Disturbance of flocculant blanket in treatment	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Treatment	2	2	2	Bacterial growth in rapid gravity filters	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Treatment	1	1	1	Algal growth in rapid gravity filters and clarifiers	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Potable transport (water quality)	1	1	1	Increased pluvial flooding leads to infiltration of potable water mains; bacterial contamination risk	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.
DWSP	Potable transport (water quality)	3	3	3	Saline intrusion of potable water mains (non-metallic mains)	Incorporate risk into DWSP; operationally managed risk. Communicate climate and hydrology data.	Continued source-to-tap water quality monitoring.

9.3 Climate Risks Managed Through Water Resources Management Planning and Drought Planning

9.3.1 Risks

The Company does not consider that serious risks to the supply-demand balance driven by climate change will materialise over the near term, i.e. within the next 20-30 years. This is because near term risks are reflected and mitigated in the current WRMP.

One water resources risk has been scored as a 'medium' risk in the near term. This is the increased risk of breach of environmental flow conditions (Hands Off Flow agreements) due to naturally lower flows in the water courses driven by climate change. This reduces the reliability of sources for public water supply, and is likely to impact the Company's operations during our critical period in water resources planning; peak demand. Further environmental flow agreements may result from the Company's AMP 5 investigations driven by the Habitats Regulations and the Water Framework Directive. The WRMP guidance does not allow this risk to be reflected in headroom.

Six further strategic risks were identified that the Company expects will materialise in the medium term (approximately mid-Century). In descending criticality (risk score), these are:

- Increased demand for water at peak from permanent population, driven by reduced rainfall and higher temperatures
- Increased demand from seasonal (tourist) population at peak
- Increased occurrence of drought
- Increased demand from net inward migration of retirement population
- Increased summer abstraction by other (existing) catchment users due to reduced rainfall
- Increase in agriculture leads to increase in abstraction by other catchment users

In the long term, the Company expects these risks to increase. Saline intrusion or tidal inundation of borehole sources may become a moderate risk by the end of the Century, particularly at the Fishbourne site.

9.3.2 Opportunities

The Company has identified two potential opportunities to the supply-demand balance driven by climate change.

- Increased aquifer recharge during a normal winter, from increased winter rainfall, may lead to more water being available for use during the summer months, and during peak demand, due to the three-month time lag in the aquifer. This opportunity does not exist following a dry winter, however.
- Increased soil fracturing during the summer, driven by hotter temperatures, may lead to accelerated aquifer recharge when rains begin. Certainty in this theory is very low.

Risk management mechanism	Business function	Risk score (near term)	Risk score (medium term)	Risk score (long term)	Risk description	Action	Validation
WRMP	Water resources	5	20	25	Increased demand for water at peak from permanent population, driven by reduced rainfall and higher temperatures	Research risk through Water UK, UKWIR, Company population data, links with university projects. Incorporate risk in to future water resources management planning cycles as per regulatory guidelines and implement demand management and/or supply schemes as required.	Outturn data of distribution input, weather impacts, consumption monitors, etc. (June Return)
WRMP	Water resources	5	20	25	Increased demand from seasonal (tourist) population at peak	Continued engagement with regional planners. Review third party data. Incorporate risk in to future water resources management planning cycles as per regulatory guidelines and implement demand management and/or supply schemes as required.	Outturn data of distribution input, weather impacts, consumption monitors, etc. (June Return)
WRMP and DP	Water resources	5	15	20	Increased occurrence of drought	Review Level of Service in next water resources management planning cycle. Assess impacts of climate change on Drought Plan.	None.
WRMP	Water resources	3	9	15	Increased demand from net inward migration of retirement population	Continued engagement with regional planners. Review third party data. Incorporate risk in to future water resources management planning cycles as per regulatory guidelines and implement demand management and/or supply schemes as required	Outturn data of distribution input, weather impacts, consumption monitors, etc. (June Return)
WRMP	Water resources	9	9	12	Increased risk of breach of environmental flow requirements in water courses, reducing reliability of sources for public water supply	Undertake AMP 5 investigations, continued engagement with Environment Agency.	Continued river flow gauging (Portsmouth Water and Environment Agency)

Risk management mechanism	Business function	Risk score (near term)	Risk score (medium term)	Risk score (long term)	Risk description	Action	Validation
WRMP	Water resources	3	9	12	Increased summer abstraction by other (existing) catchment users due to reduced rainfall	Continued engagement with Environment Agency and regional planners. Make use of third party data. Share knowledge through WRSE and Water UK.	None.
WRMP	Water resources	3	9	12	Increase in agriculture leads to increase in abstraction by other catchment users	Continued engagement with Environment Agency and regional planners. Make use of third party data. Share knowledge through WRSE and Water UK.	None.
WRMP	Water resources	4	4	8	Saline intrusion of borehole sources	No action required at this stage. Review next round of sea level rise projections and aquifer modelling as they become available.	Continued conductivity monitoring will identify salinity.
WRMP	Water resources	5	5	5	Rising salinity at River Itchen intake	No action required. Review next round of sea level rise projections and shoreline management policies as they become available.	Continued conductivity monitoring will identify salinity.
WRMP	Water resources	5	5	5	Reduced aquifer recharge during summer months causes reduced summer source yield	Continue to work with the Environment Agency and other stakeholders on aquifer modelling.	Continued groundwater level and source yield monitoring.
WRMP	Water resources	2	2	4	Population migration away from flood risk impacts regional supply-demand balance	Continued engagement with regional planners. Ongoing monitoring.	Outturn data of distribution input.
WRMP	Water resources	2	4	4	Increased evapotranspiration reducing aquifer recharge	Continue to work with the Environment Agency and other stakeholders on aquifer modelling.	Continued groundwater level and source yield monitoring.
WRMP	Water resources	2	2	4	Water resources asset loss from coastal change	Continued engagement with regional planners. Ongoing monitoring.	Existing conductivity monitoring will identify salinity.
WRMP	Water resources	4	4	4	Saline intrusion from lower groundwater / increased abstraction	No action required.	Review next round of sea level rise projections and shoreline management policies as they become available. Existing conductivity monitoring will identify salinity.

Risk management mechanism	Business function	Risk score (near term)	Risk score (medium term)	Risk score (long term)	Risk description	Action	Validation
WRMP	Water resources	3	3	3	Reduced aquifer recharge during summer months leads to reduced source yield in October	Continue to work with the Environment Agency and other stakeholders on aquifer modelling.	Existing conductivity monitoring will identify salinity.
WRMP	Water resources	2	2	2	Saline intrusion of Havant and Bedhampton Springs source	Ongoing monitoring.	Existing conductivity monitoring will identify salinity.
WRMP	Water resources	2	2	2	Population migration away from coastal change impacting regional supply-demand balance	Continued engagement with regional planners. Ongoing monitoring.	Outturn data of distribution input.
WRMP	Water resources	1	1	1	Increased soil compaction reduces aquifer recharge	Continue to work with the Environment Agency and other stakeholders on aquifer modelling.	Continued groundwater level and source yield monitoring.

9.4 Climate Risks Managed Through Resilience and Emergency Planning

9.4.1 Risks

Risks driven by climate change managed through resilience and Emergency Planning are considered low in the near term. This is because the Company has an active Emergency Plan which incorporates flooding events and storms. The Company is also undertaking flood resilience improvements at sites at risk, during AMP 5.

In the medium term, three strategic risks were assessed as moderate. These are:

- Increased flooding to source and treatment works from rivers and groundwater
- Increased flooding to pumping stations (raw and potable) and valves from rivers and groundwater
- Increased regional flooding from rivers and groundwater impedes routine mains repair

The risk rating for these risks increases in the long term. Three further risks were also identified which may impact the Company in the long term:

- Road melt events impede treatment works access
- Increased interruptions to telecommunications and telemetry, driven by storminess.

9.4.2 Opportunities

No opportunities to resilience and Emergency Planning were identified.

Risk management mechanism	Business function	Risk score (near term)	Risk score (medium term)	Risk score (long term)	Risk description	Action	Validation
Resilience, Emergency Planning	Abstraction, treatment, raw and potable transport	3	9	12	Increased flooding to source and treatment works from rivers and groundwater	Review new flood maps as they become available. Risk already incorporated in to Emergency Plan. Consider future risk when procuring new or replacement assets.	Continued monitoring of asset performance and failure data.
Resilience, Emergency Planning	Raw transport, potable transport	3	6	9	Increased flooding to pumping stations (raw and potable) from rivers and groundwater	Review new flood maps as they become available. Risk already incorporated in to Emergency Plan. Consider future risk when procuring new or replacement assets.	Continued monitoring of asset performance and failure data.
Resilience, Emergency Planning	Potable transport	3	6	9	Increased regional flooding from rivers and groundwater impedes routine mains repair	Review new flood maps as they become available. Risk already incorporated in to Emergency Plan.	Continued monitoring of asset performance and failure data.
Resilience, Emergency Planning	Treatment	2	4	6	Road melt events impede treatment works access	Incorporate in to Emergency Plan.	None.
Resilience, Emergency Planning	Abstraction, raw transport, treatment, potable storage, potable transport	3	3	6	Increased interruptions to telecommunications and telemetry	Ongoing monitoring.	Continued monitoring of asset performance and failure data.
Resilience, Emergency Planning	Abstraction, treatment, raw and potable transport	2	2	4	Increased pluvial flooding to works and pumping stations	Review new flood maps as they become available. Risk already incorporated in to Emergency Plan. Consider future risk when procuring new or replacement assets.	Continued monitoring of asset performance and failure data.
Resilience, Emergency Planning	Abstraction, raw transport, treatment, potable storage, potable transport	2	2	4	Storm damage to above ground assets (buildings and overhead cables)	Risk already incorporated in to Emergency Plan. Consider future risk when procuring new or replacement assets.	Continued monitoring of asset performance and failure data.

Risk management mechanism	Business function	Risk score (near term)	Risk score (medium term)	Risk score (long term)	Risk description	Action	Validation
Resilience, Emergency Planning	Potable transport	2	2	4	Road melt events impede routine mains repair	Incorporate in to Emergency Plan.	None.
Resilience, Emergency Planning	Potable transport	2	2	4	Increased regional pluvial flooding impedes routine mains repair	Review new flood maps as they become available. Risk already incorporated in to Emergency Plan. Consider future risk when procuring new or replacement assets.	Continued monitoring of asset performance and failure data.
Resilience, Emergency Planning	Potable storage	3	3	3	Service reservoir monitoring equipment failure due to flooding	Review new flood maps as they become available. Risk already incorporated in to Emergency Plan. Consider future risk when procuring new or replacement assets.	Continued monitoring of asset performance and failure data.
Resilience, Emergency Planning	Abstraction	1	1	2	Road melt events impede abstraction works access	Incorporate in to Emergency Plan.	None.
Resilience, Emergency Planning	Abstraction, raw transport, treatment, potable storage, potable transport	1	1	2	Increased interruptions to electricity supply	Risk already incorporated in to Emergency Plan. Consider future risk when procuring new or replacement assets.	Continued monitoring of asset performance and failure data.
Resilience, Emergency Planning	Raw transport	1	1	2	Road melt events impede raw water boosters access	Incorporate in to Emergency Plan.	None.
Resilience, Emergency Planning	Abstraction, raw transport, treatment, potable storage, potable transport	1	1	2	Increased interruptions to electricity supply	Risk already incorporated in to Emergency Plan. Consider future risk when procuring new or replacement assets.	Continued monitoring of asset performance and failure data.

10. CLIMATE CHANGE ADAPTATION ACTION PLAN

This section sets out the actions the Company will undertake to address the strategic climate change risks identified in this process.

The following tables show strategic climate risks grouped by risk management mechanism and risk score, and the required action and validation.

10.1 Capital Planning Actions

10.1.1 Action 1: Incorporate Climate Change Risks in to Investment Decision-Making

10.1.1.1 Implementation

Build capacity within capital investment and engineering teams to understand future climate risks and incorporate into feasibility study and options appraisal.

This will include, but is not limited to:

- considering future temperature and sunlight exposure when procuring or developing new M&E, control, and treatment assets
- considering future flood risk and coastal change when developing new assets
- considering climate change asset deterioration drivers when developing new and replacement water mains.

The level of climate change that is appropriate to consider will depend upon the life and criticality of the asset.

This builds upon recent work by the Company to incorporate carbon emissions analysis in to investment decision-making for climate change mitigation.

10.1.1.2 Responsibility

The Regulation Manager will be responsible for implementation of this action during 2011.

The Regulation Manager will review the extent of implementation in AMP 6 to identify the materiality of impacts upon decision-making, and identify data gaps and barriers.

10.1.1.3 Validation

Continued monitoring of asset performance data for capital maintenance planning will identify trends in performance of cohorts of assets. A decline in performance of an asset group may indicate a climate driver. The Supply and Investment Manager is the owner of this data.

10.1.2 Action 2: Build Capacity Within Asset Performance Modellers in Understanding Climate Change Impacts

10.1.2.1 Implementation

It is important that asset performance and deterioration modellers understand how climate change may drive asset deterioration and thus capacity must be built in this respect. Asset modellers will be provided with the findings from this risk assessment and will be briefed in UKCP09.

10.1.2.2 Responsibility

The Regulation Manager will be responsible for implementation of this action during 2011.

The Regulation Manager will review the extent of implementation in AMP 6 to identify the materiality of impacts upon decision-making, and identify data gaps and barriers.

10.1.3 Action 3: Review the Case in AMP 6 for Incorporating Climate Change Impacts in to Asset Deterioration Modelling

10.1.4.1 Implementation

No action is current required as immediate climate risks to asset deterioration are considered to be low. However, this will be reviewed in AMP 6 following the AMP 5 project to improve asset performance monitoring and modelling techniques.

10.1.3.2 Responsibility

The Regulation Manager will be responsible for implementation of this action during AMP 6.

10.1.4 Action 4: Continued Engagement with Regional Planners and Decision Makers

10.1.4.1 Implementation

No further action required.

The Company routinely engages with other planners and decision makers in the region. For example, the Company participates in a number of regional fora covering resilience, water management, spatial planning, pollution management and biodiversity. The Company also participates in consultations on these matters.

Incorporating and reacting to future rounds of flood management plans, shoreline management plans, spatial plans and flood mapping will continue to be a part of this process.

The Company recognises that as the climate changes it is increasingly important to maintain communication with other planners and decision makers.

10.1.4.2 Responsibility

Engage with stakeholders and planners cuts across all business functions. Senior managers are responsible.

10.1.4.3 Validation

None required.

10.1.5 Monitoring Residual Risk and Critical Thresholds

Continued monitoring of asset performance and failure data, energy consumption data, and the outcomes of the Company's project to improve asset failure modelling techniques will enable changes and trends in asset deterioration and efficiency to be identified.

Continued monitoring of water quality from will identify any saline intrusion events in our assets and raw supplies.

10.2 Drinking Water Safety Planning Actions

10.2.1 Action 5: Incorporate the water quality findings of the climate change risk assessment in to the Drinking Water Safety Plans

10.2.1.1 Implementation

Water quality risks are managed operationally. Capital investment may be instigated when the risk becomes unacceptable.

The water quality findings of the climate change risk assessment will be incorporated in to the DWSPs and will inform long term water quality management strategy.

Water quality teams will be briefed on UKCP09 and future hydrological modelling outcomes.

10.2.1.2 Responsibility

The Water Quality Manager will be responsible for implementation of this action during 2011.

The Water Quality Manager will review the extent of implementation in 2012 to identify data gaps and barriers.

10.2.1.3 Validation

The existing source-to-tap water quality monitoring for DWSP will identify trends in water quality and the frequency of water quality events.

Water quality teams within the business have a comprehensive understanding of the relationship between water quality and weather variables, such as impacts upon algal growth, bacterial growth, chlorine depletion, pollutant concentrations, turbidity events and process disruption, as outlined in this report. Climate drivers of trends in water quality and the frequency of events will therefore be identified.

10.2.2 Monitoring Residual Risk and Critical Thresholds

Continued monitoring of water quality from source to tap will enable changes in residual risk to water quality to be identified.

10.3 Resilience and Emergency Planning Actions

10.3.1 Action 6: Review Next Round of Environment Agency Flood Mapping as they become Available

10.3.1.1 Implementation

The Company will be made aware of new developments in flood mapping through the regional resilience for a and standing data transfer agreements.

The Company incorporates the mapping on the business' GIS system and makes use of the findings.

10.3.1.2 Responsibility

The Distribution Manager, as owner of the Emergency Plans, will be responsible for ongoing maintenance of flood information.

10.3.1.3 Validation

None required.

10.3.2 Action 7: Incorporate emergency weather event risks in to investment decision-making

10.3.2.1 Implementation

It is important to consider future risks of emergency events when developing new and long-term assets. This is incorporated in to Action 1 in Capital Planning and requires no further implementation.

10.3.2.2 Responsibility

The Regulation Manager will be responsible for implementation during 2011.

The Regulation Manager will review the extent of implementation in AMP 6 to identify the materiality of impacts upon decision-making, and identify data gaps and barriers.

10.3.2.3 Validation

Continued monitoring of asset performance data for capital maintenance planning will identify trends in events leading to asset outage and damage. The Supply and Investment Manager is the owner of this data.

10.3.3 Action 8: Incorporate heat wave and road melt events in to Emergency Plans

10.3.3.1 Implementation

The Emergency Plans detail operational measures to adopt during an emergency event that affects customers. This includes extreme weather such as storms, floods and drought. As heatwaves may become much more frequent in the future, it is prudent to reflect these in the Emergency Plans.

Emergency planning staff will be briefed in UKCP09 and the findings of the climate change risk assessment to assist in developing the emergency measures.

10.3.3.2 Responsibility

The Distribution Manager will be responsible for implementation during AMP 5.

10.3.3.3 Validation

None required.

10.3.4 Monitoring Residual Risk and Critical Thresholds

Continued Monitoring of asset performance and failure data will enable changes in residual risk to be identified.

10.4 <u>Water Resources Management Planning and Drought Planning Actions</u>

10.4.1 Action 9: Continue to research climate change drivers of water demand at average and at peak

10.4.1.1 Implementation

The Company undertakes research on the drivers of demand for water through a number of mechanisms. These include:

- Water UK
- UKWIR projects
- Club projects
- Company data; distribution input, consumption monitors
- Review of other trials and research, such as the Environment Agency and Waterwise

- International examples
- Links with universities on research projects

The Company will continue to make use of this data and incorporate the risks in to water resources management planning alongside other drivers of demand.

10.4.1.2 Responsibility

The Regulation Manager is responsible for demand forecasting in water resources management planning.

10.4.1.3 Validation

Outturn data on distribution input and consumption monitors identify trends in demand.

10.4.2 Action 10: Continued engagement with regional planners and decision makers on water demand issues

10.4.2.1 Implementation

No further action required.

The Company routinely engages with other planners and decision makers in the region on aspects including spatial strategies, housing forecasts, social change, water efficiency and the Code for Sustainable Homes.

Change in population size, population demographic, household water fittings, and regional economic activity (such as increased tourism) will be monitored in part through these mechanisms.

The Company recognises that as the climate changes it is increasingly important to maintain communication with other planners and decision makers.

10.4.2.2 Responsibility

The Regulation Manager is responsible for demand forecasting in water resources management planning.

The Human Resources Manager is responsible for delivery of the water efficiency programme, however, this has a separate regulatory driver and falls outside the scope of this adaptation plan.

10.4.2.3 Validation

Outturn data on distribution input and consumption monitors identify trends in demand.

10.4.3 Action 11: Continued Engagement with other Stakeholders the Environment Agency on other Catchment Abstractors

10.4.3.1 Implementation

The Company expects hotter, drier summers will lead to increased abstraction by other catchment operators. These abstractors may be unlicensed. Increased sunlight (reduced cover) may also lead to an increase in agriculture and horticulture in the region, and associated abstractions.

The Company will continue engagement with the Environment Agency on this risk and will learn from other water companies through Water Resources in the South East and Water UK.

10.4.3.2 Responsibility

The Regulation Manager is responsible for water resources management planning.

10.4.3.3 Validation

None.

10.4.4 Action 12: Research pressures on risk of breach of environmental flow requirements in water courses

10.4.4.1 Implementation

During AMP 5 the Company will be undertaking investigations related to the Habitats Regulations and the Water Framework Directive on the impact of abstraction on ecology. This will include hydrological modelling work, which will enable increased understanding of the risk, although the studies may result in further ‘hands off flow’ agreements.

This impact must be understood and incorporated in to future water resource management planning cycles.

10.4.4.2 Responsibility

The Regulation Manager is responsible for forecasting water available for use in water resources management planning.

10.4.4.3 Validation

Continued analysis of the following data, and the relationships between them:

- Existing water course flow gauging mechanisms, by the Company and by the Environment Agency
- Outturn abstraction data
- Existing source yield data.

The Regulation Manager is the owner of this data within the Company.

10.4.5 Action 13: Continued research of impacts of climate change and seasonal aquifer characteristics

10.4.5.1 Implementation

Work with the Environment Agency and other stakeholders to understand how climate change will impact aquifer recharge and groundwater levels throughout the year.

Reflect the risk in future water resources management planning cycles.

10.4.5.2 Responsibility

The Regulation Manager is responsible for forecasting water available for use in water resources management planning.

10.4.5.3 Validation

Continued groundwater and source yield monitoring.

10.4.6 Action 14: Review Level of Service in the next water resources management planning cycle

10.4.6.1 Implementation

The level of service is reviewed each water resources planning cycle. This will become increasingly important when considering the impacts of climate change.

The Company will make use of drought modelling data produced through UKWIR projects.

10.4.6.2 Responsibility

The Regulation Manager is responsible for water resources management planning.

10.4.6.3 Validation

None.

10.4.7 Action 15: Assess impacts of climate change on 2011 Drought Plan

10.4.7.1 Implementation

Climate change is expected to increase the occurrence of drought events, from minor drought events to sever drought events. The Company is vulnerable to multiyear droughts as the Company has no year-on-year storage assets. The

Drought Plan is an operational plan, however, climate change will impact upon the Company's implementation of measures during a drought event.

The impacts of climate change on drought events and drought management will therefore be reviewed following the production of the 2011 Drought Plan.

The Company will make use of drought modelling data produced through UKWIR projects.

10.4.7.2 Responsibility

The Regulation Manager is responsible for drought planning.

10.4.7.3 Validation

None.

10.4.8 Monitoring Residual Risk and Critical Thresholds

10.4.8.1 Saline Intrusion

Company water sources are considered to be at very low risk of loss or outage from coastal change. The existing raw water quality monitoring, such as conductivity monitoring and telemetry data, will identify any salinity events at source works if they occur.

The Company will also continue to benefit from future runs of the regional hydrological model, owned by the Environment Agency.

10.4.8.2 Population Migration

Changes to the supply-demand balance from population migration will be identified from distribution input and water demand data. New housing developments will be incorporated by the Company's existing mechanisms.

10.4.8.3 Source yield

The Company monitors groundwater levels and springs yield, and abstraction. Impacts on water availability will be identified through these mechanisms.

10.5 Communication Plan

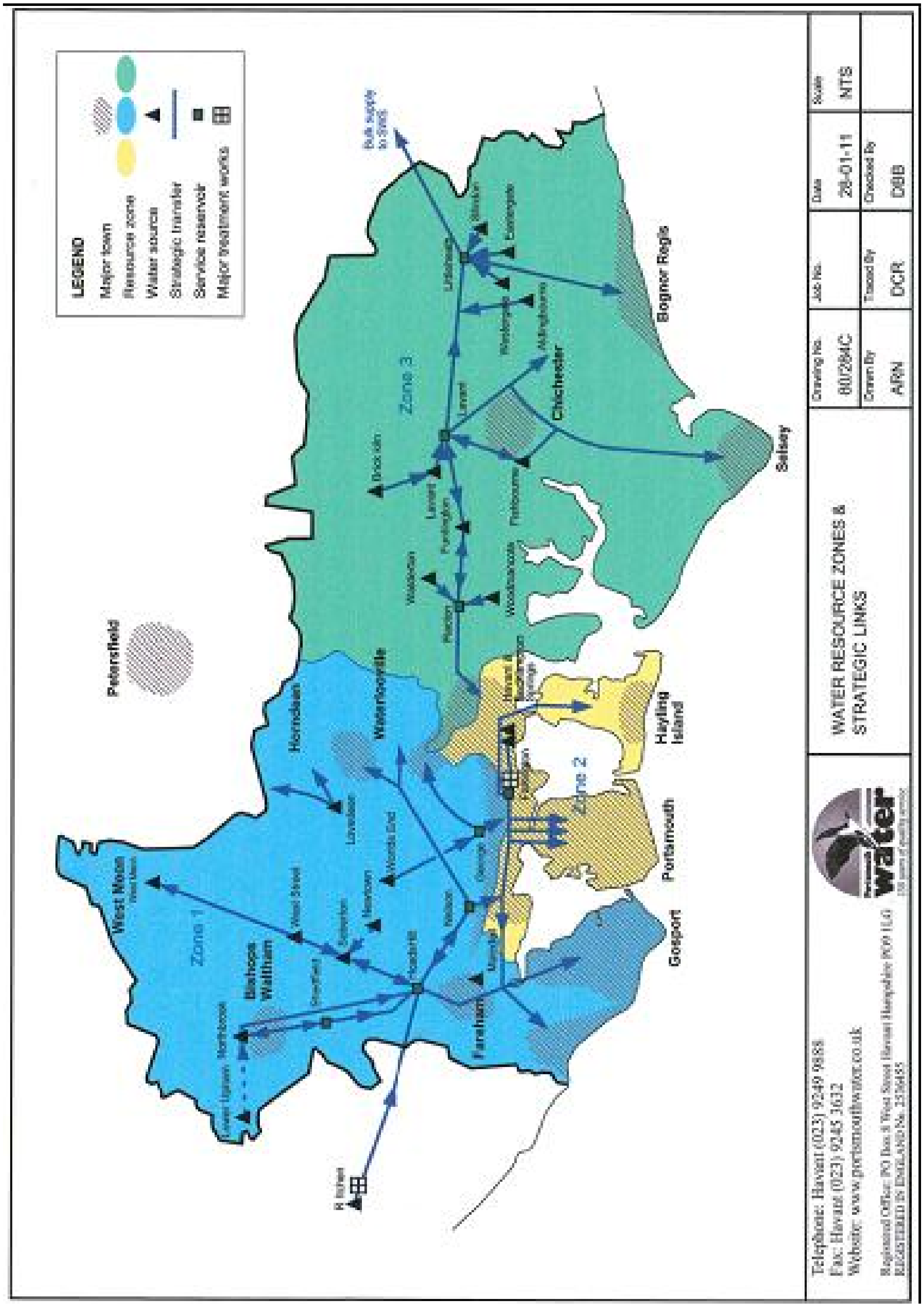
Climate change risks and the resulting adaptation plan to address these risks will be communicated through the following mechanisms:

- General briefing of senior managers in climate change drivers, and the risks and actions identified

- Briefing at the Company's internal sustainability group, comprised of representatives from regulation, procurement, emergency planning, water efficiency, energy management, data management and water quality

- Specific engagement with owners of actions and data as appropriate.

APPENDIX 1: Water Resources Zones and Strategic Links RESTRICTED DOCUMENT



APPENDIX 2: Portsmouth Water Periodic Review 2009 Flood Resilience Assessment (February 2009) RESTRICTED DOCUMENT

1. EXECUTIVE SUMMARY

The Company has a long history of providing public water supplies to the Portsmouth area for over 150 years. All but one of its supplies comes from groundwater and hence the Company, and the area in general, does not generally suffer from major fluvial flooding. It is, however, at risk from coastal flooding events associated with high tides and also during wet winters, elevated groundwater in normally dry catchments can result in prolonged periods of groundwater flooding which may continue for several months.

Major flooding events in the summer of 2007, in Gloucestershire, Yorkshire and other parts of the UK, resulted in a number of major investigations by Sir Michael Pitt, Ofwat and Water UK. The recommendations of those reports have formed the basis of this assessment of the resilience of the Company's infrastructure to flooding, the potential impacts upon customers' supplies and the proposed improvements which the Company believes it should include in its AMP5 Investment Plans.

Although a number of sources were developed in the 1800s, many more were developed by the Company in the 1960s and 1970s. The Company, therefore, does not have a long history of information about the resilience of some of its infrastructure although during the winters of 1993/94, 1994/5 and 2000/01 several sites were affected by groundwater flooding. The winter of 2000/01 saw groundwater levels rise to their highest in a record of over 70 years at Idsworth Well, the Company's key groundwater monitoring location.

The review of the 2007 floods by **Sir Michael Pitt** called upon the Environment Agency, Local Resilience Fora and the infrastructure providers, to review risks and policies as well as to put in place closer liaison on dealing with events. In all, 85 recommendations were made.

An **Ofwat** report challenged water companies to review their risk assessments in the light of the 2007 experiences, with a view to bringing forward investment plans for the PR09 Periodic Review.

The **Water UK** review repeated many of the recommendations of the other bodies with particular emphasis being placed upon the liaison with other groups, both within and outside of the industry such as the Water Industry Mutual Aid Scheme. They also identified the need to provide emergency arrangements for customers, ensure adequate communication arrangements and regular rehearsals of emergency plans.

The Company has conducted a flood risk assessment of all of its key infrastructure using the Environment Agency's Flood Plain Assessment

Maps which identify fluvial and coastal flood risks as well as by reference to its own experience of groundwater flooding events. The Environment Agency's assessment refers to:

High Risk Sites where there is a likelihood of fluvial flooding once in 100 years or coastal flooding once in 200 years.

Low Risk Sites where there is a likelihood of flooding once in 1,000 years.

All Treatment Works Pumping and Booster Stations, Service Reservoirs, Pressure Control Valves and Strategic Transfer Valve sites have been assessed.

Access difficulties to each of the sites is also considered. The review in tabular form is as follows:

Site	Environment Agency Assessment	Portsmouth Water Experience	Access Problems
Treatment Works			
Aldingbourne	High	None	Yes
Brickkiln	None	None	Yes
Eastergate	None	Now Resolved	No
Farlington	None	None	No
Fishbourne	None	Now Resolved	No
Funtington	None	None	No
Lavant	High	Extensive	Yes
Lovedean	None	None	No
Maindell	None	None	No
Northbrook	None	None	Yes
River Itchen	None	None	No
Slindon	None	None	No
Soberton	None	None	No
Walderton	None	Part of Site	Yes
Westergate	None	Extensive	Yes
West Meon	None	None	No
West Street	Low	Part of Site	Yes
Woodmancote	None	None	No
Worlds End	None	None	No
Pumping/Booster Stations			
Havant	Low	None	No
Bedhampton	Low	None	Yes
Street End	None	None	No
Fir Down	None	None	No
Lavant	None	None	No
Appledown	None	None	Yes
Nore Hill	None	None	No
Whiteways	None	None	No
Hambledon	None	None	No
Highdown	High	Extensive	Yes
Shedfield	None	None	No
Fort Southwick	None	None	No

Fort Nelson	None	None	No
West Marden	None	None	Yes
Leigh Park	None	None	No
Madehurst	None	None	No
Hoe	None	None	No
Portchester	None	None	No
Titchfield	None	None	No
Hogs Lodge	None	None	No
Nursery	None	None	No
Service Reservoirs			
All	None	None	No
Pressure Control Valves			
Chichester	None	None	No
Witterings	None	None	No
Gosport	None	None	No
Bognor	None	Part of Site	Yes
Portsmouth (Hilsea)	High	None	Yes
Portsmouth (Eastern)	High	None	Yes
Hayling Island	High	None	Yes
Strategic Transfer Valves			
All	None	None	No
Others			
Hilsea Tunnel	High	None	Yes

The security of supplies has been the principal concern of customers in recent research. The Company recognises that over recent years, that it has developed improved interconnectivity of its network such that short-term shutdowns of many of its sites can be accommodated without major interruptions to customers' supplies. In addition, it has approximately two days storage in most service water supplies.

However, several key sites are the principal sources for particular reservoir zones and in the event of a shutdown they rely upon augmentation from neighbouring zones. The key issue for Portsmouth Water to recognise is the fact that flooding events affecting its infrastructure are expected to be the result of groundwater flooding of catchments. Since groundwater flooding affects a wide area, it therefore expects a number of sources to be affected at the same time and also that these events will be prolonged, in fact up to several months as was the case in the winter of 2000/01.

Climate change forecasts, produced by the UK Climate Impacts Programme, suggest that the country, and especially the South East of England, should plan for more extreme events in the future, and that they are likely to become more frequent.

Identifying the financial consequences of major interruptions is difficult to quantity, although the Company understands that the cost to Severn Trent Water of the floods affecting the Mythe Water Treatment Works was over £20m. That event interrupted supplies to 350,000 consumers. For the purposes of arriving at a simplistic cost-benefit analysis, the Company has calculated the costs of paying a £30 compensation payment to those customers potentially at risk of interruptions to supplies. The financial impacts of providing emergency supplies and other clean up costs are difficult to quantify and so the Company uses these compensation costs as a proxy in its cost benefit calculations.

At all of the Environment Agency's 'Low-Risk' sites which are only expected to be affected in a source (1 in 1,000 year flood), the Company does not believe that it can justify resilience improvements. It does not believe that its customers would be willing to fund measures for such a remote event.

For all 'High Risk' sites modest improvements are proposed. The Company has identified low cost protective measures at Aldingbourne Water Treatment Works where the provision of 'flood-boards' and airbrick covers are proposed. At Lavant and Westergate Water Treatment Works, the Company proposes the construction of high level cable entries and the raising of motor control panels to avoid flood inundation of electrical equipment within the control buildings of each.

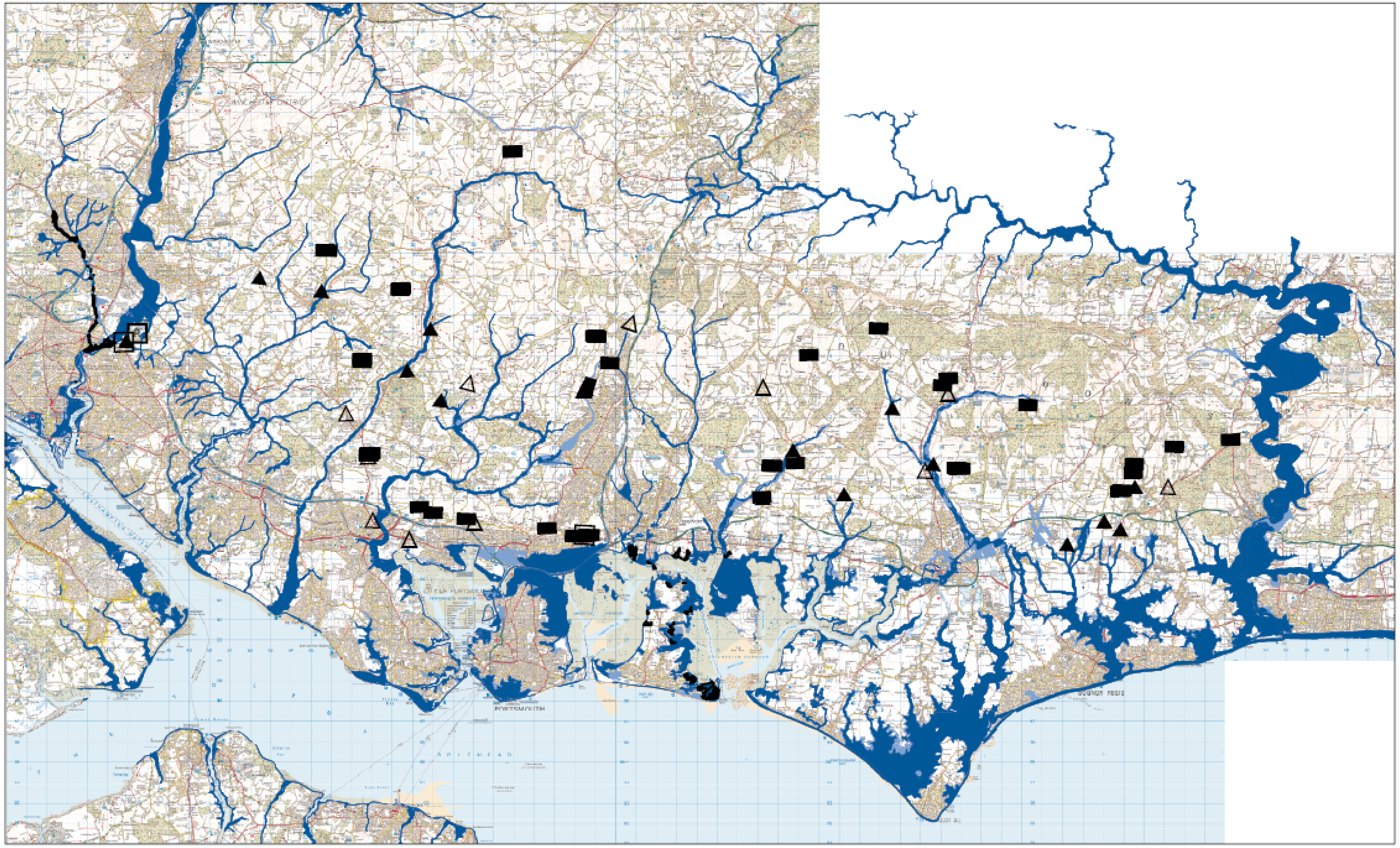
The responses to the remaining recommendations of the 2007 Flood Reports are not expected to result in any costs to the Company.

A simple cost benefit analysis based upon the minimum financial outlay resulting from compensation payments due to interruptions suggests that these would be at least four times the costs of the improvements works proposed.

Site	**Potential Properties Affected**	**Potential Compensation Payments**	**Estimated Improvement Costs**
Aldingbourne WTW	6,416	£192,480	£10,000
Lavant WTW	13,571	£407,130	£105,000
Westergate WTW	14,116	£423,480	£105,000
Totals	**34,103**	**£1,023,090**	**£220,000**

Given the modest scale of the improvement works proposed, the Company believes that it can complete the works by the end of the 2011/12 financial year.

Appendix 3a: River and Coastal Flood Mapping in Portsmouth Water's Operational Area



KEY

- Flood Zone 3
- Flood Zone 2
- Booster
- Source works
- Service reservoir
- Treatment works

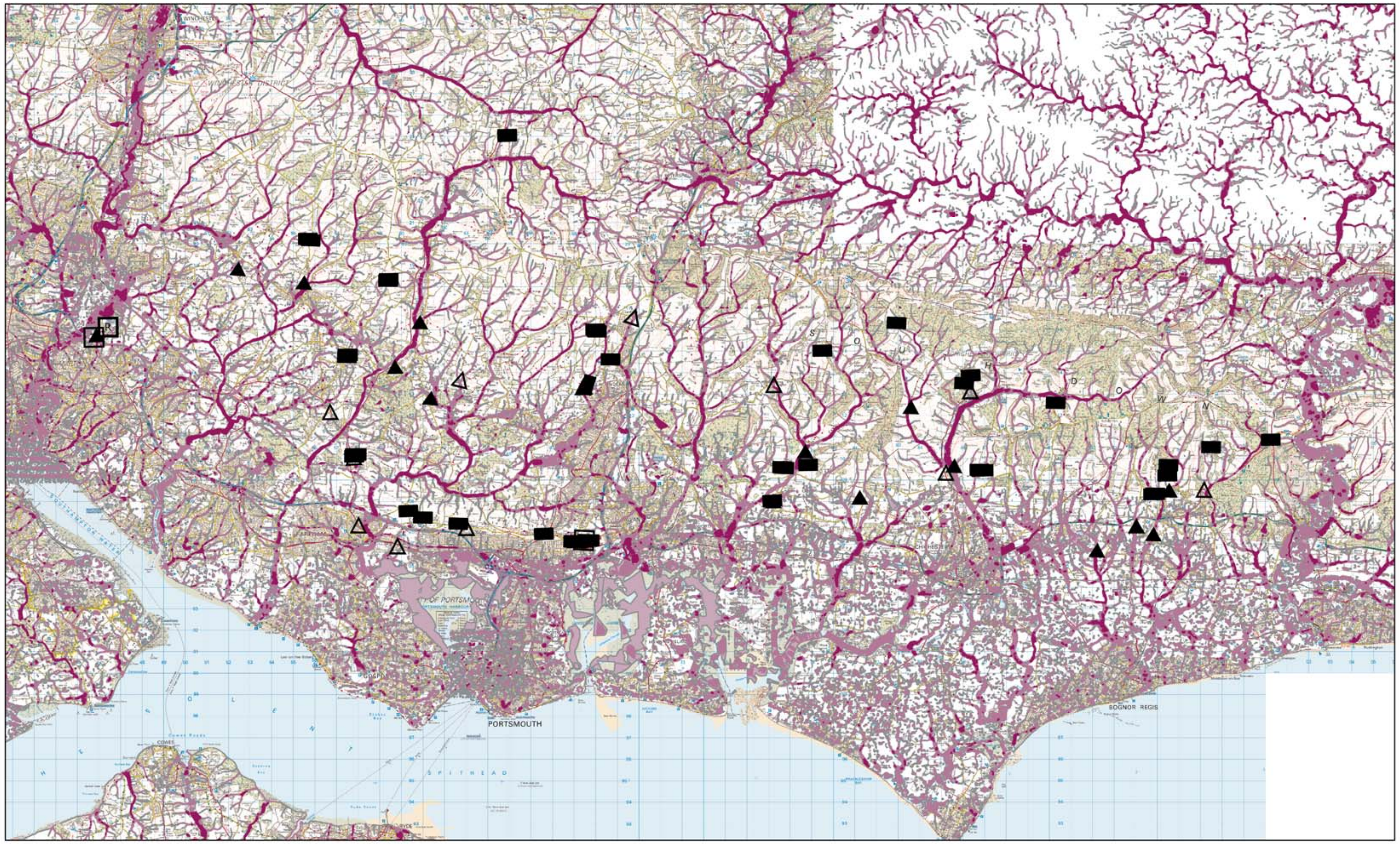
Portsmouth water
150 years of quality service

Registered Office
P.O. BOX NO. 8, West Street, Havant, Hampshire. PO9 1LG.
Registered in England No. 2536455
Telephone: (023) 9249 9888
Fax: (023) 9245 3632
Website: www.portsmouthwater.co.uk

The information supplied is given in good faith as a guide to locating underground apparatus. Its accuracy cannot be guaranteed, nor does it include comprehensive information about the existence or location of service pipes or cables to individual premises. The responsibility for locating and avoiding damage to apparatus on site shall be that of the person proposing to excavate in the street who shall be liable to the apparatus owner and any third party who may be affected in any way for any loss or damage caused by their failure to do so.

Drg No:	
Job No:	
OS Ref:	SU7411NW
Scale:	1:180,000
Date:	14/12/2010

Appendix 3b: Surface Water Flood Mapping in Portsmouth Water's Operational Area RESTICTED DOCUMENT



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Drg No:	
Job No:	
OS Ref:	SU7311NE
Scale:	1:169,188
Date:	04/01/2011